

FIG. 1A

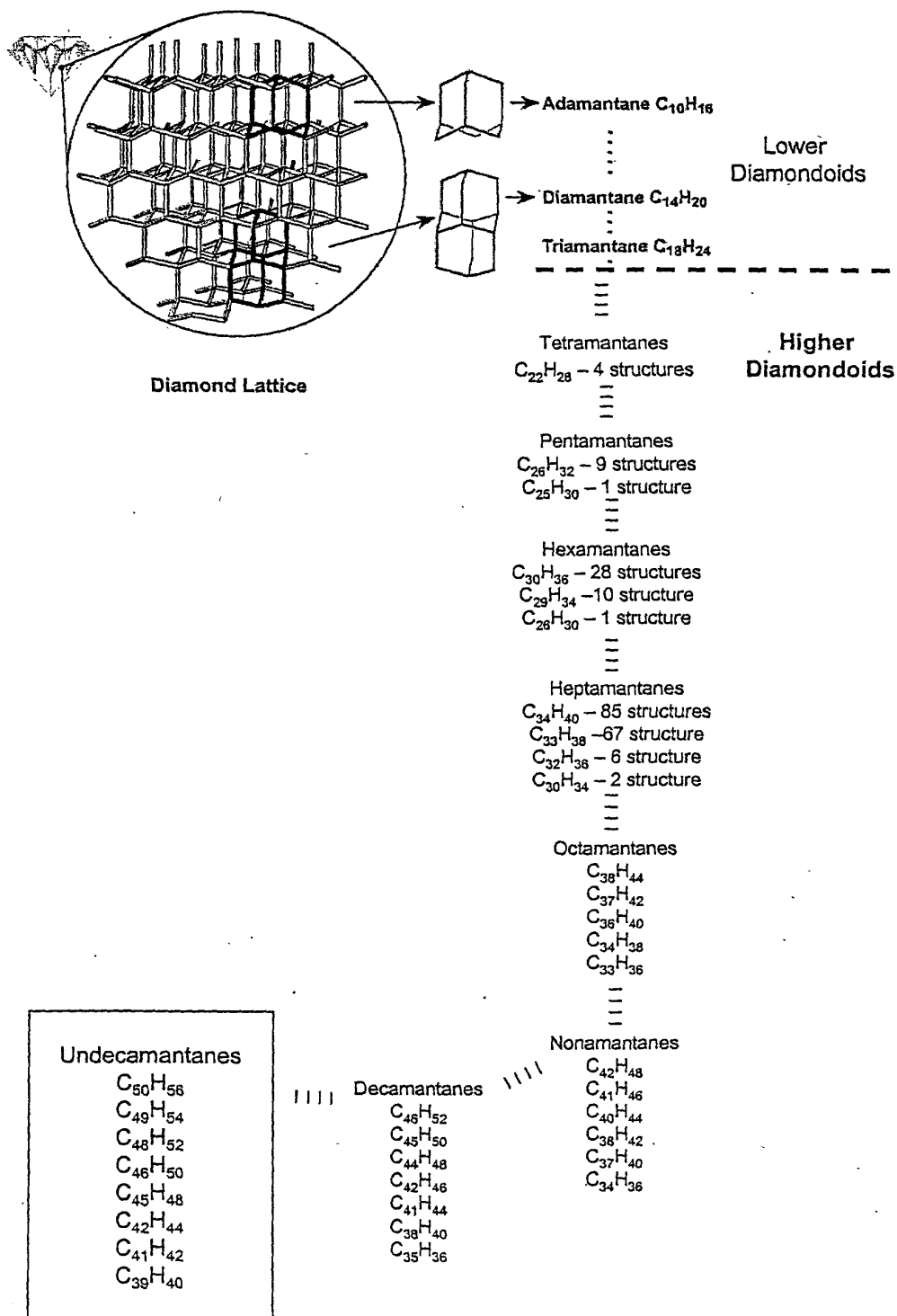
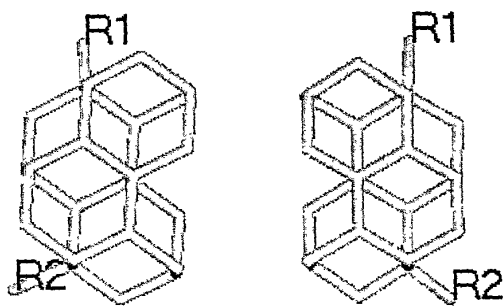
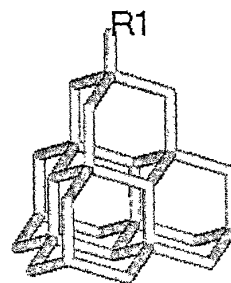


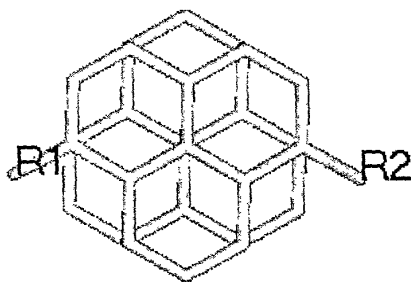
FIG. 1B



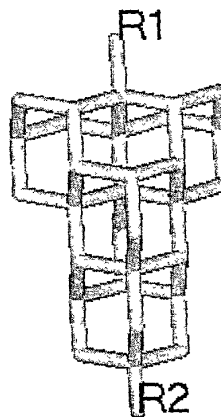
Enantiomeric [123] Tetramantanes



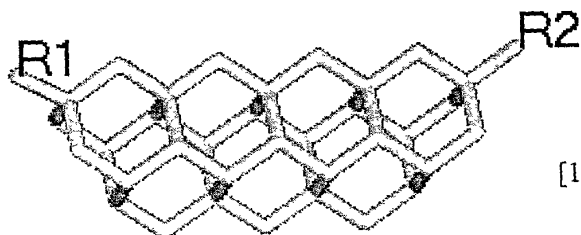
[1(2,3)4] Pentamantane



[12312] Hexamantane  
 (Cyclohexamantane)



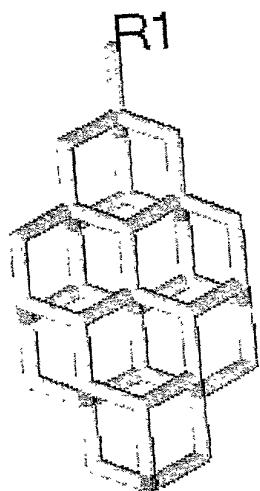
[121(3)4] Hexamantane



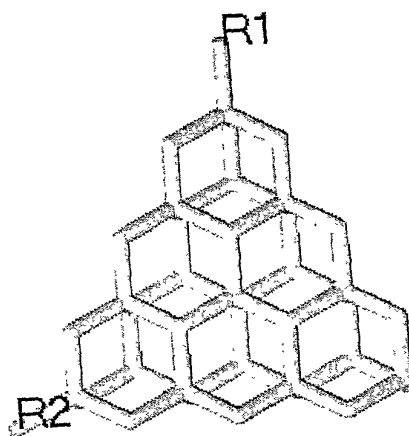
[121212] Heptamantanes

2002-01-16 09:49:00

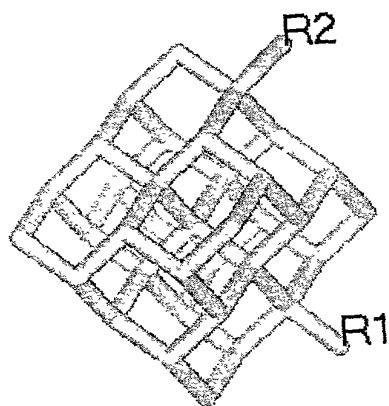
FIG. 1B  
 (continued)



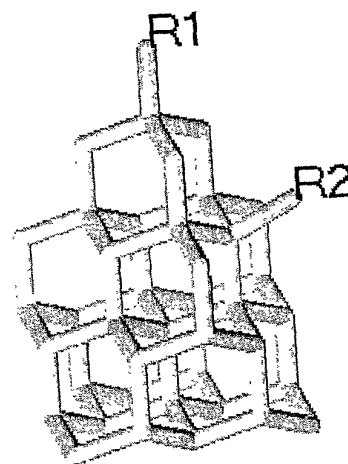
[1213(1)21] Octamantane



[121(2)32(1)3] Nonamantane



[1231241(2)3] Decamantane



[123(1,2)42143] Undecamantane

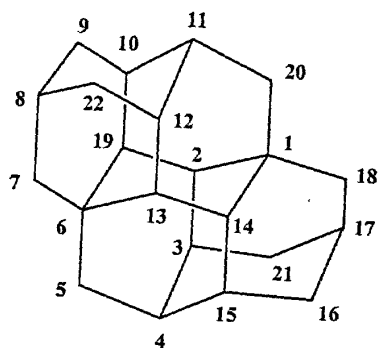
INVENTOR(S): DARR, ET AL.  
APPLICATION SERIAL NO: FILED HERewith SHEET 4 of 59

The diagram shows a complex polycyclic hydrocarbon structure, specifically a tricyclic system. The carbon atoms are labeled with their degree (1°, 2°, 3°, 4°) based on the number of other carbon atoms they are bonded to. The labels are as follows:

- 1° C (Primary):** 4 atoms (terminal carbons on the outer rings).
- 2° C (Secondary):** 6 atoms (carbons bonded to two other carbons).
- 3° C (Tertiary):** 6 atoms (carbons bonded to three other carbons).
- 4° C (Quaternary):** 2 atoms (bridgehead carbons bonded to four other carbons).

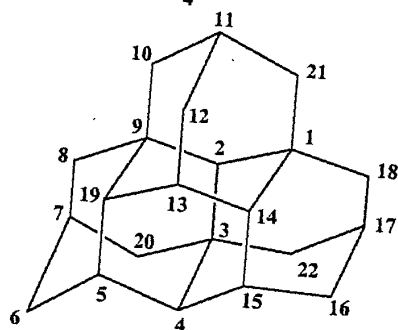
Arrows point to the labels for tertiary carbon (3° C), secondary carbon (2° C), and quaternary carbon (4° C).

FIG. 2B



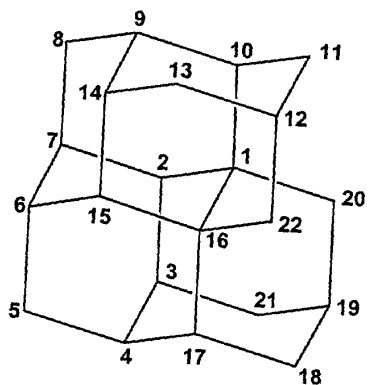
**[121] Tetramantane (*anti*-)**  
 4 non-equivalent tertiary carbons:

- 4, 11 (equivalent)
- 8, 17 (equivalent)
- 3, 10, 12, 15 (equivalent)
- 2, 13, 14, 19 (equivalent)



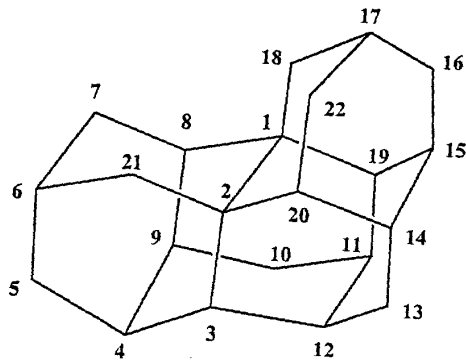
**[1[2]3] Tetramantane (*iso*-)**  
 4 non-equivalent tertiary carbons:

- 2
- 4, 14, 19 (equivalent)
- 5, 13, 15 (equivalent)
- 7, 11, 17 (equivalent)



**[123]A Tetramantane (*skew- A*)**  
 6 non-equivalent tertiary carbons:

- 6, 7 (equivalent)
- 4, 9 (equivalent)
- 3, 14 (equivalent)
- 2, 15 (equivalent)
- 10, 17 (equivalent)
- 12, 19 (equivalent)



**[123]B Tetramantane (*skew- B*)**  
 6 non-equivalent tertiary carbons:

- 6, 17 (equivalent)
- 4, 15 (equivalent)
- 11, 12 (equivalent)
- 3, 19 (equivalent)
- 9, 14 (equivalent)
- 8, 20 (equivalent)

FIG. 2C

Pentamantane

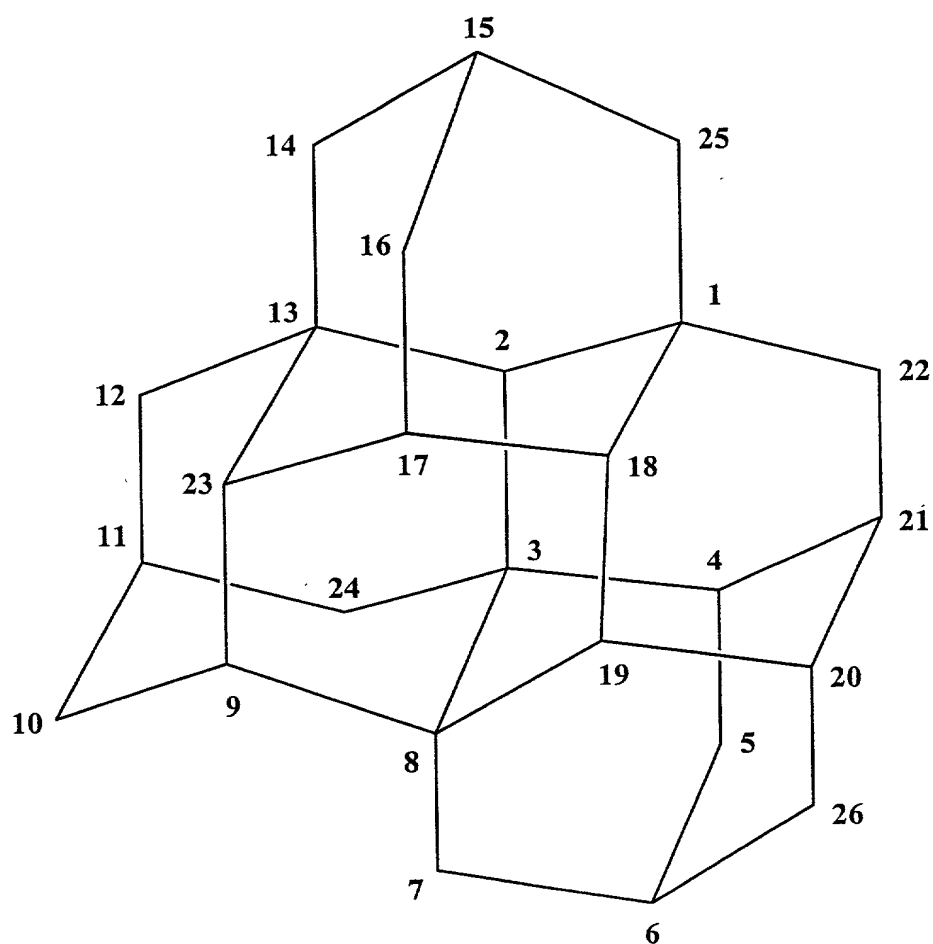


FIG. 2D

Hexamantane

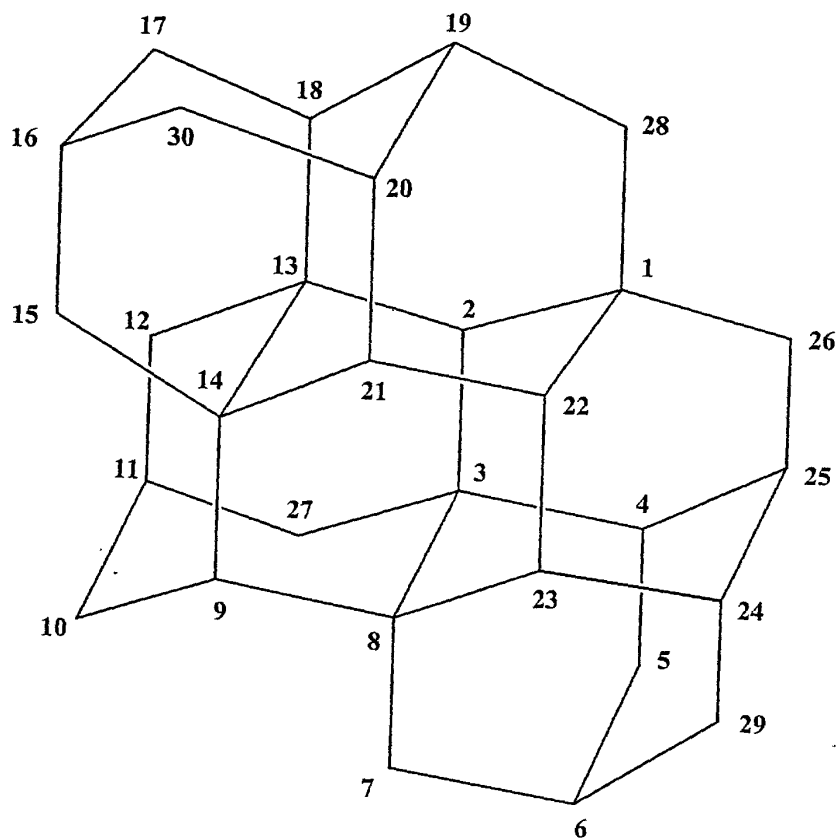


FIG. 2E

Octamantane

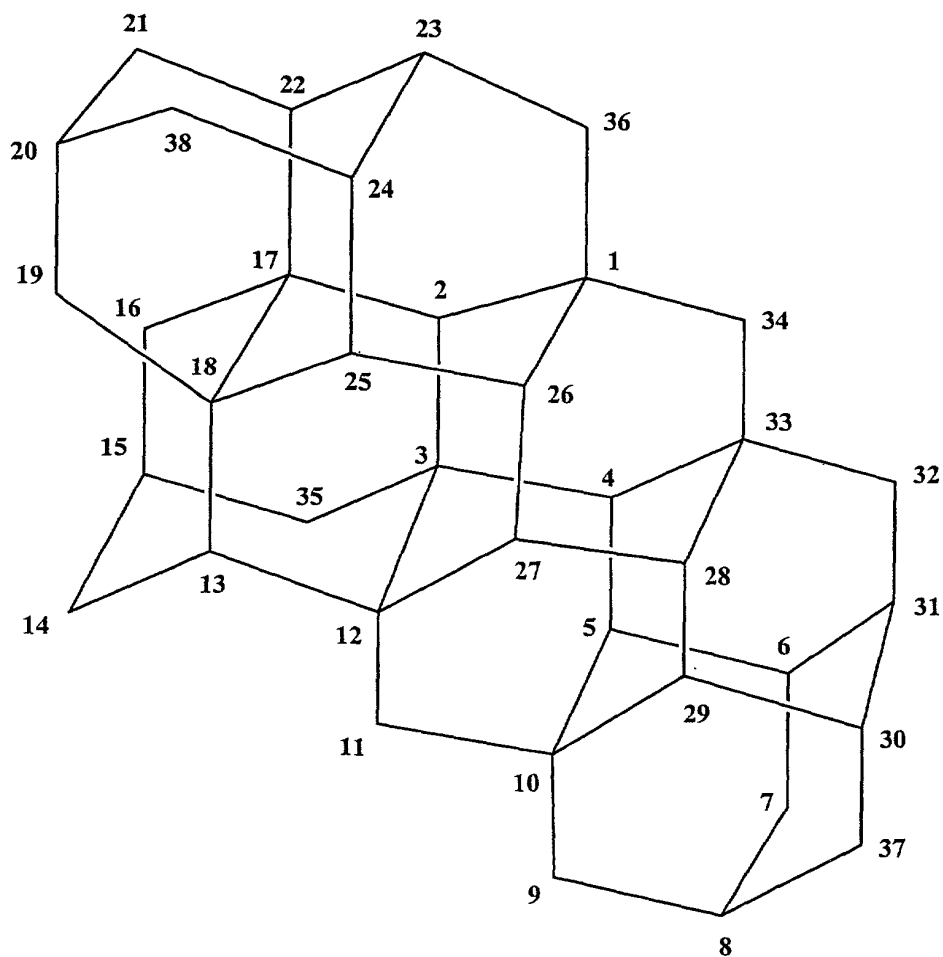




FIG. 2F

Undecamantane

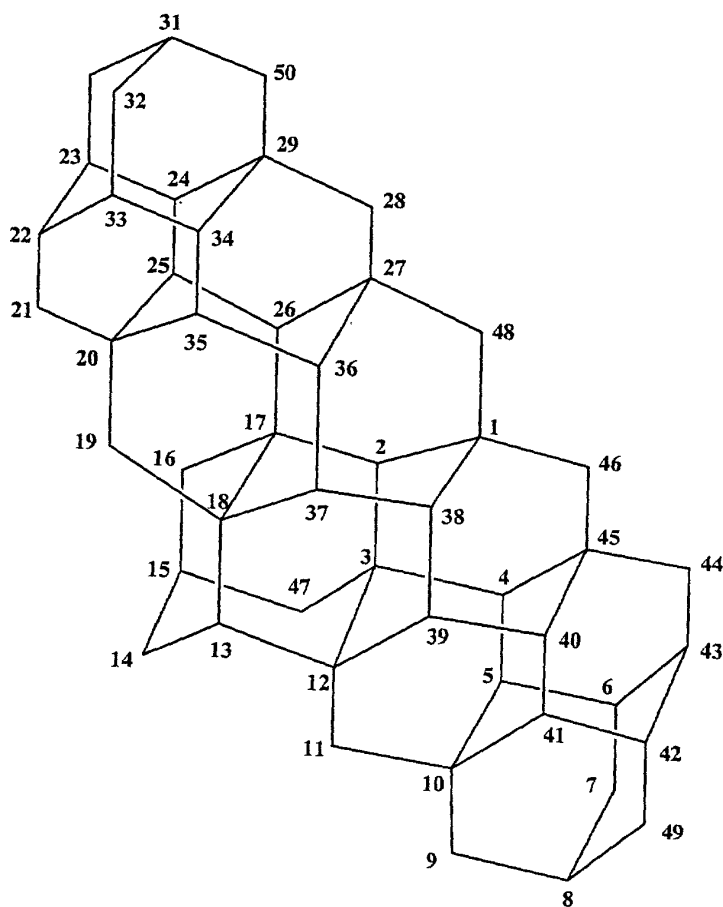


FIG. 3A

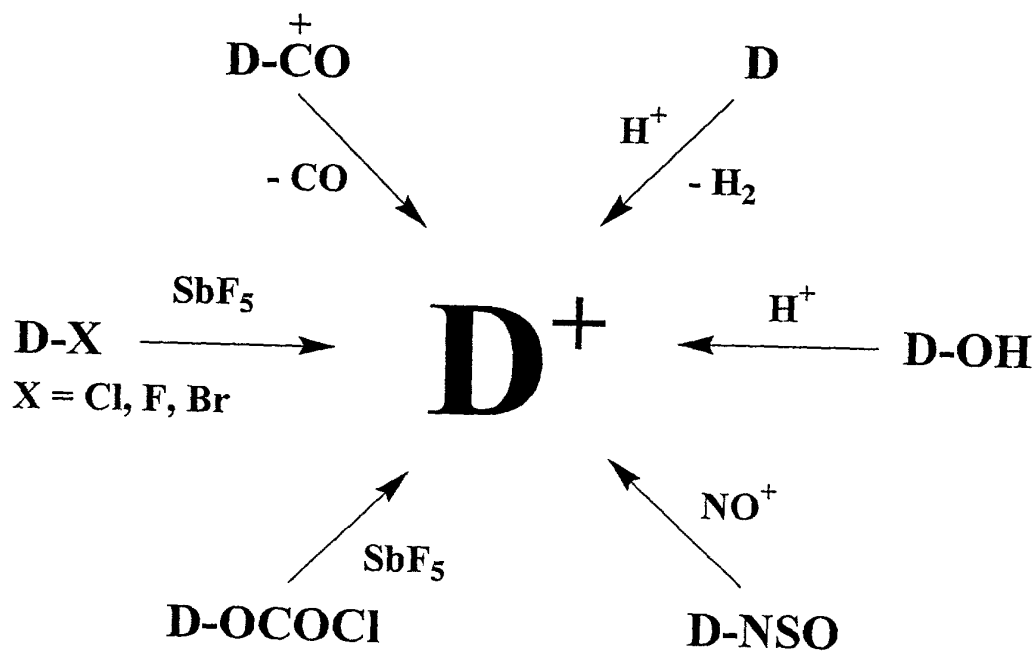


FIG. 3B

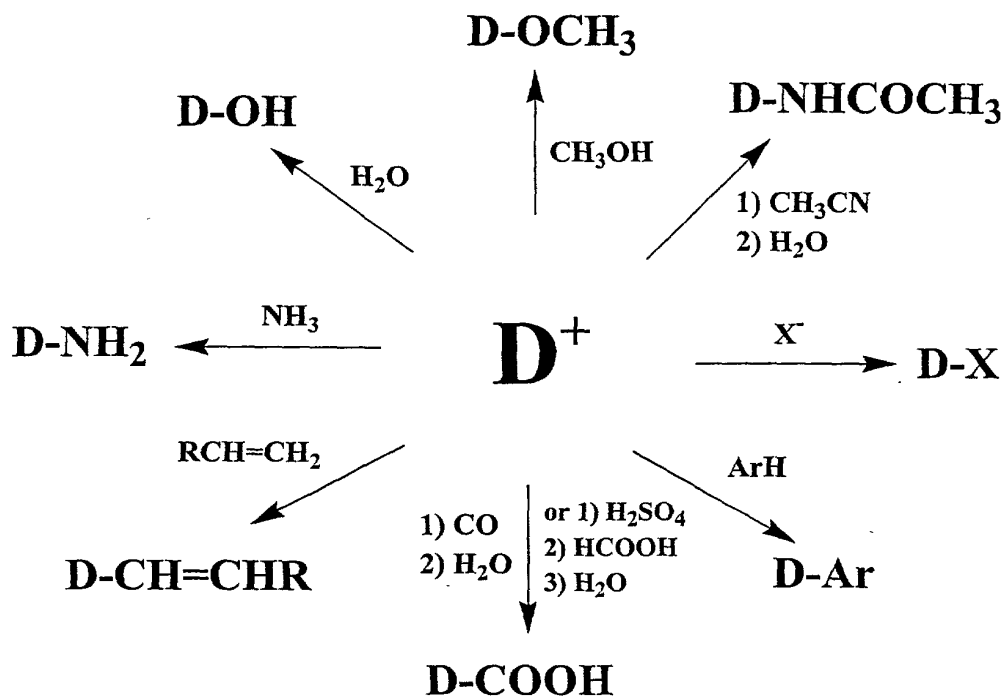


FIG. 3C

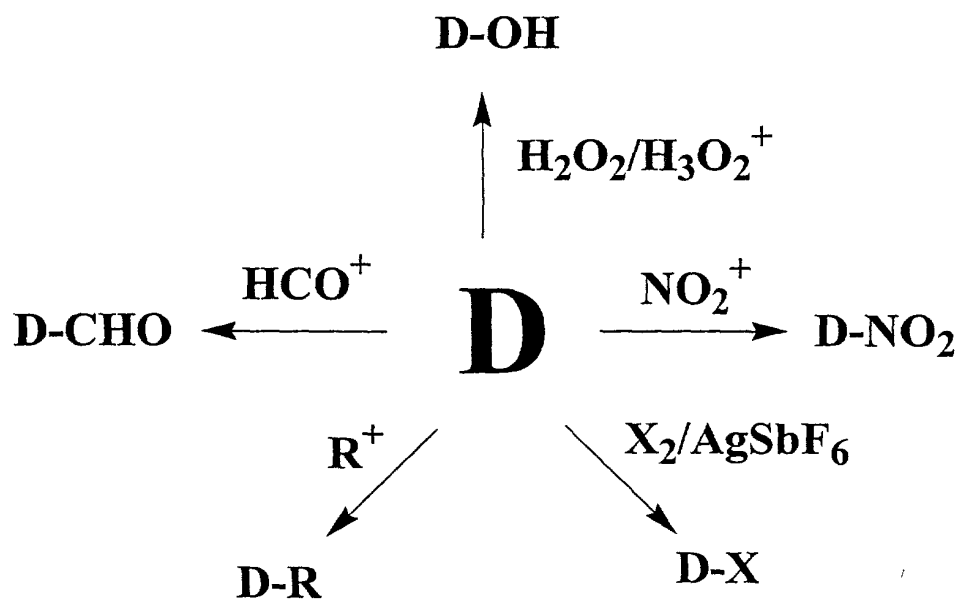


FIG. 4A

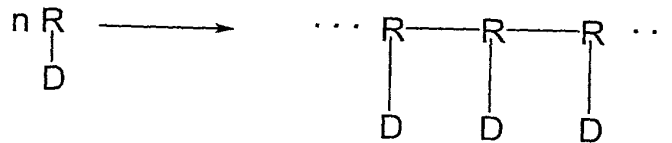


FIG. 4B

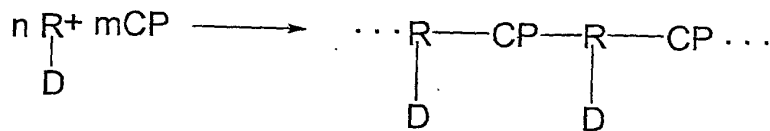


FIG. 4C

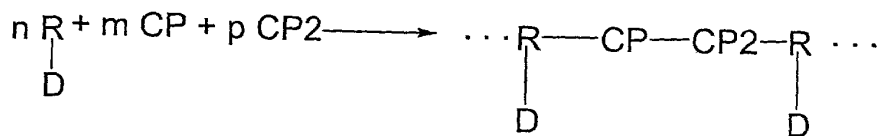


FIG. 4D

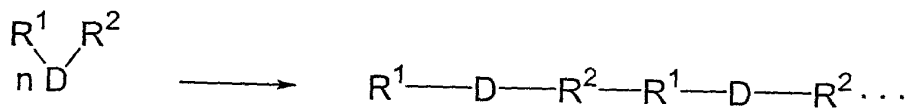


FIG. 4E

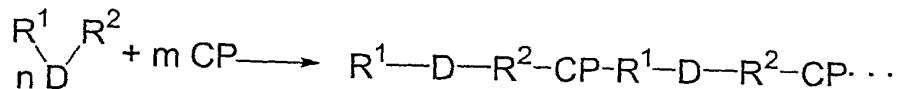


FIG. 4F

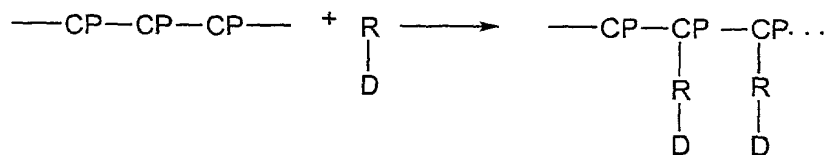


FIG. 4G

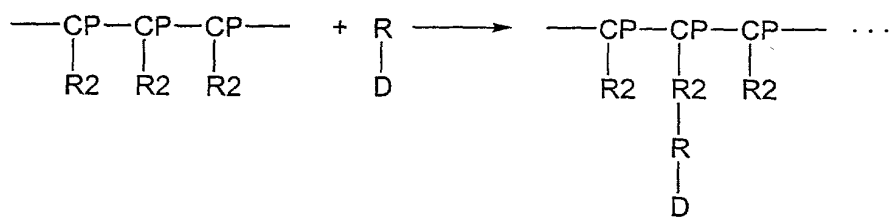


FIG. 4H

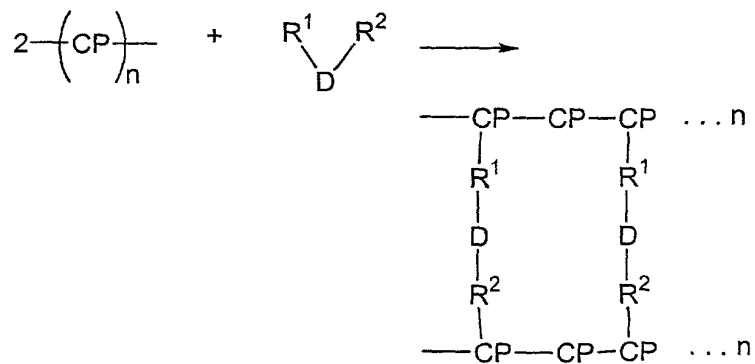
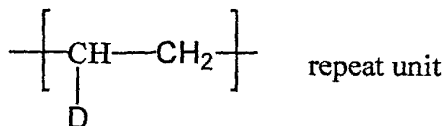
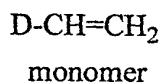


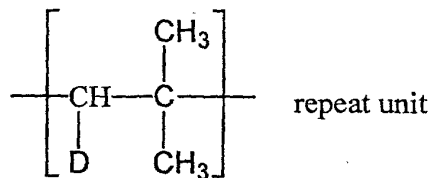
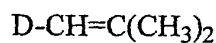
FIG. 4I

**Polyvinyl**

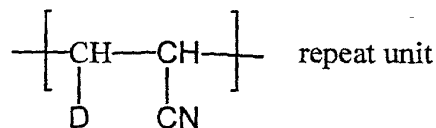
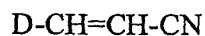


**Further vinyl addition polymers**

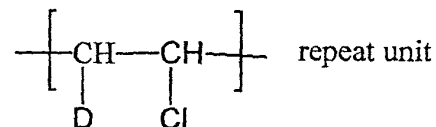
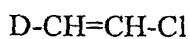
**isobutylene**



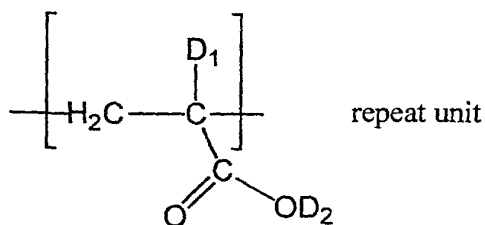
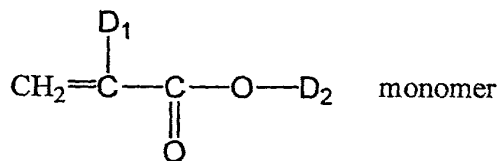
**acrylonitrile**



**vinylchloride**



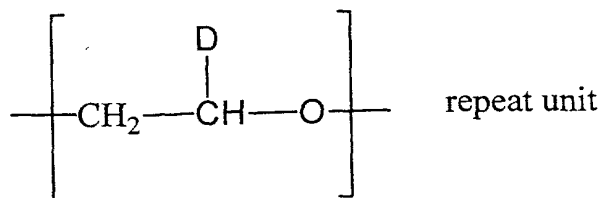
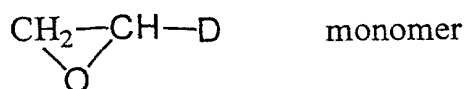
**acrylates**



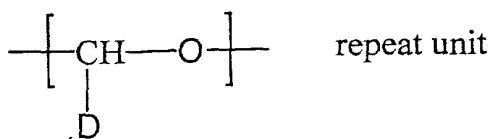
# FIG. 4I (cont.)

## Further addition polymers

Polyethylene oxide



Polyacetaldehyde

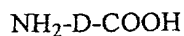




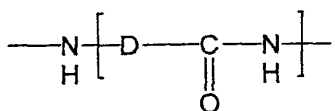
## FIG. 4I (cont.)

### Condensation polymers

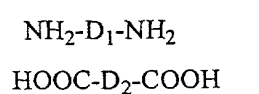
#### Polyamide



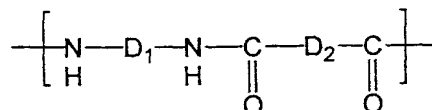
1 monomer



repeat unit



2 monomers

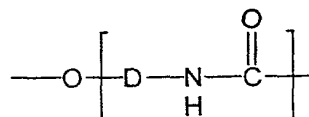


repeat unit

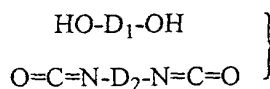
#### Polyurethane



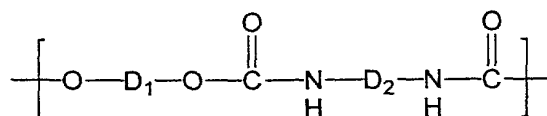
1 monomer



repeat unit

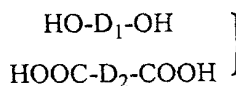


2 monomers

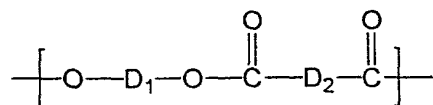


repeat unit

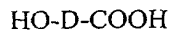
#### Polyester



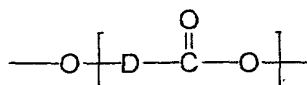
2 monomers



repeat unit



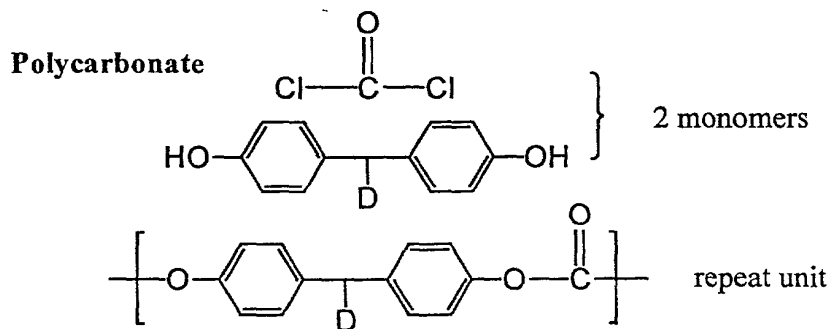
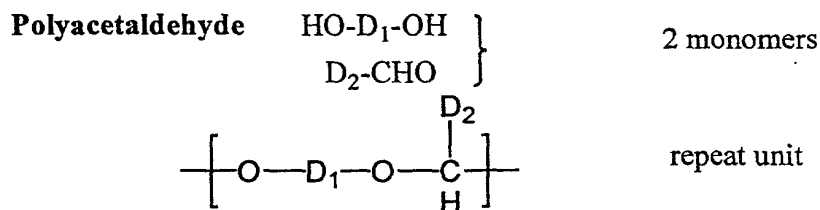
1 monomer



repeat unit

## FIG. 4I (cont.)

### Condensation polymers (cont.)



### Epoxy resins (based on epichlorohydrin - bisphenol A resins)

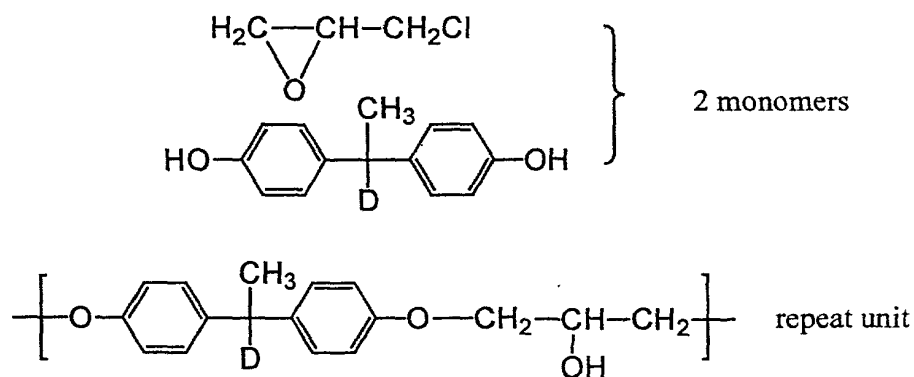
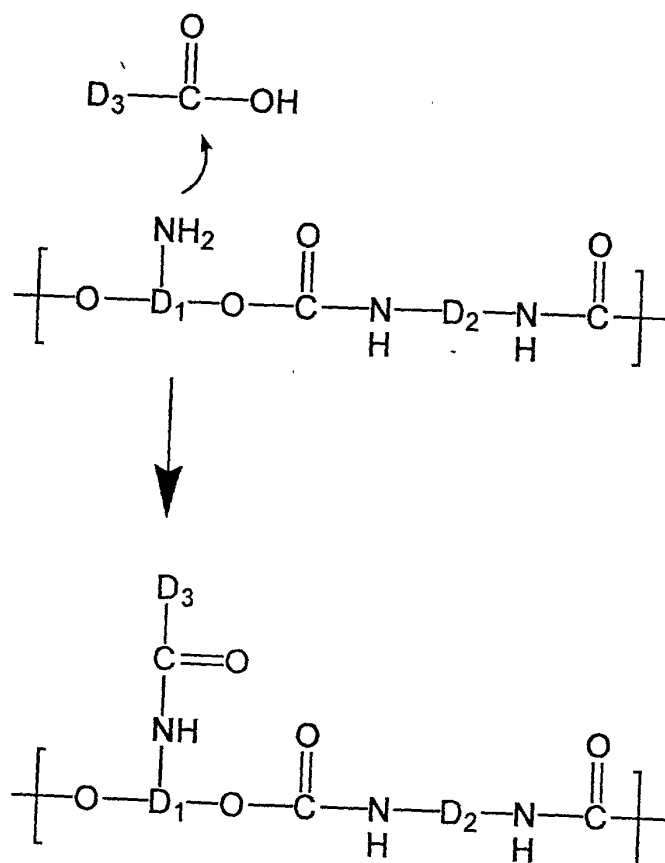


FIG. 4I (cont.)

Diamondoid-containing graft polymer



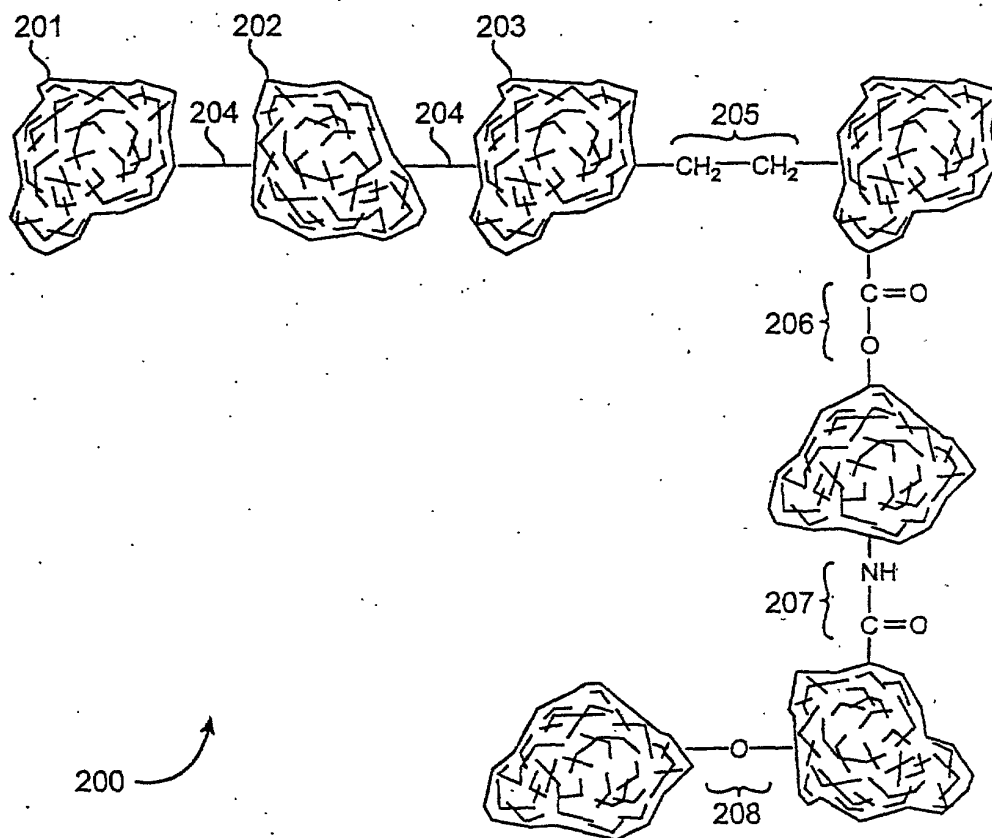


FIG. 5A

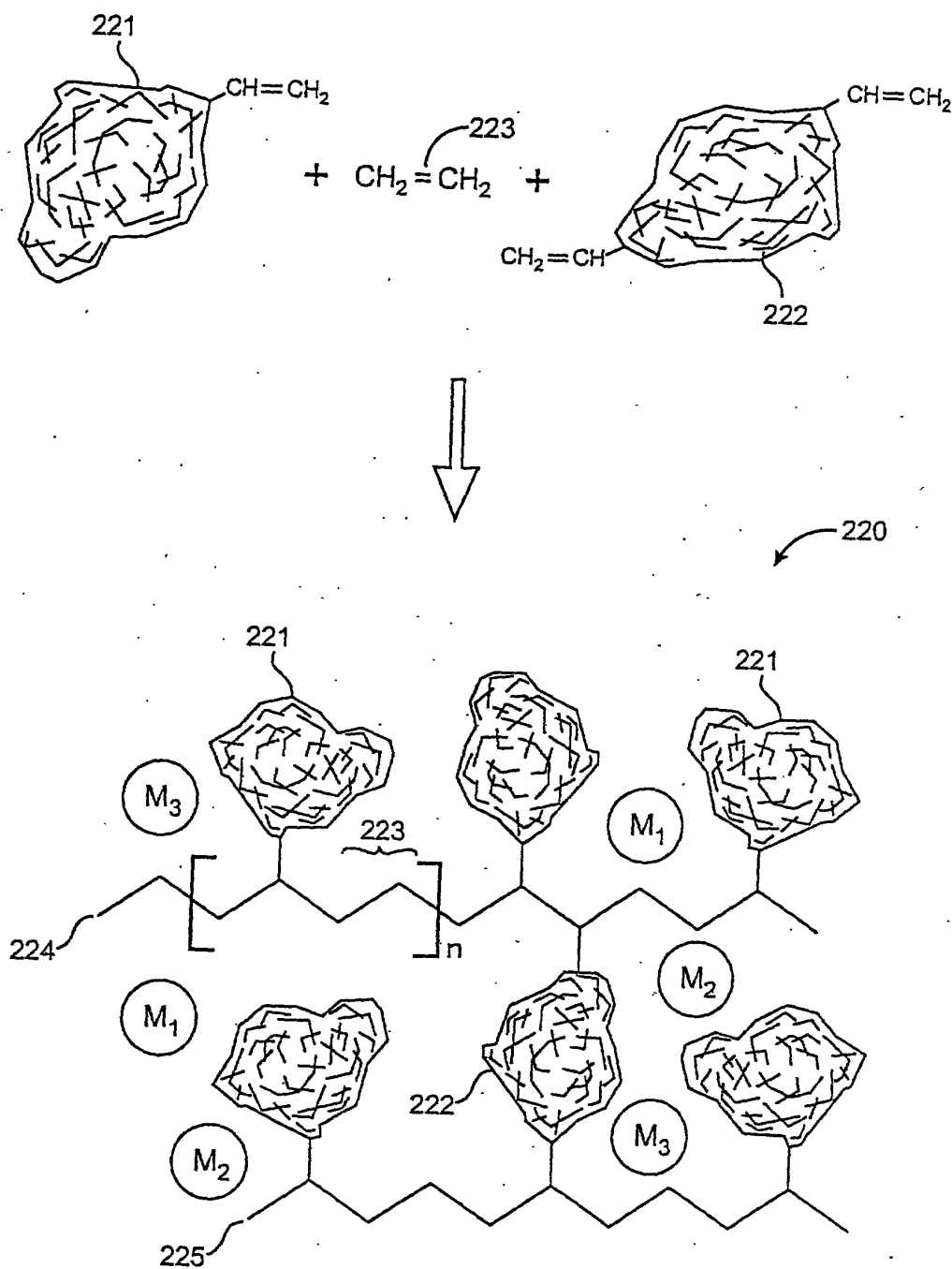


FIG. 5B

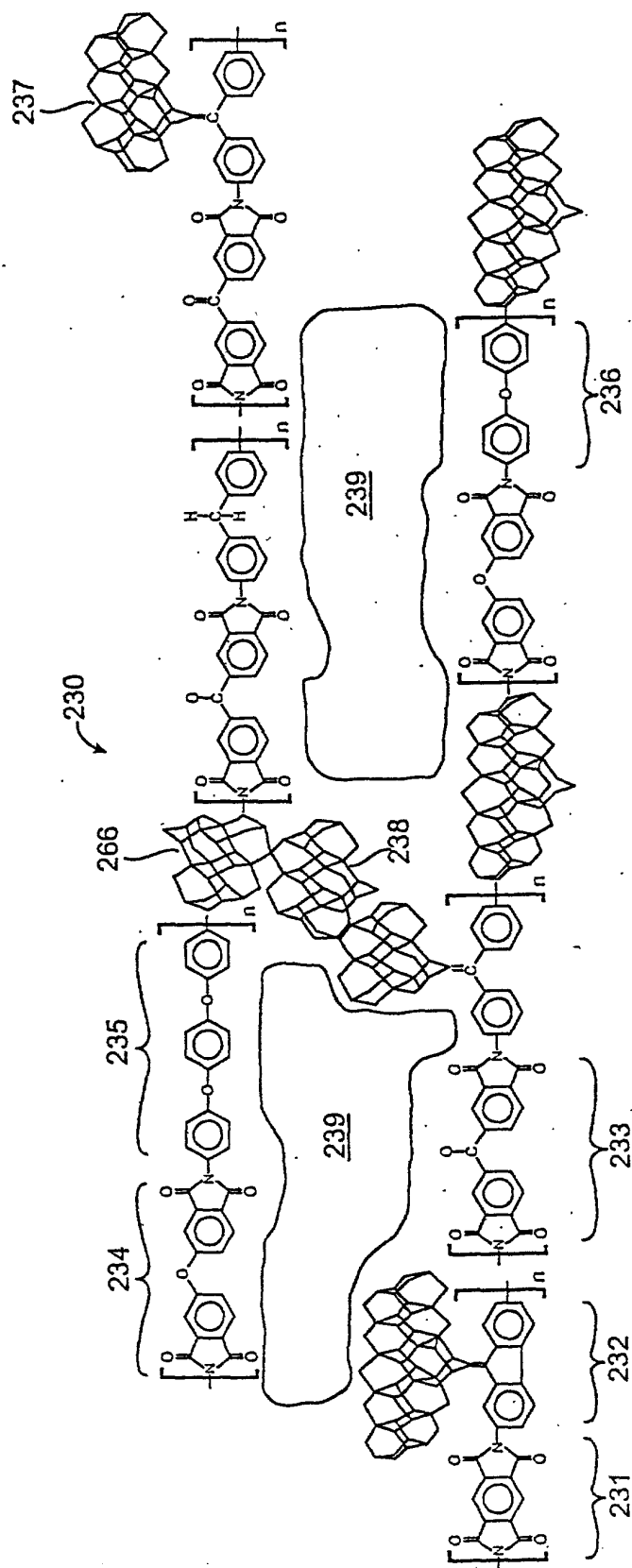


FIG. 5C

Decreasing Rigidity of Cross-linked Materials

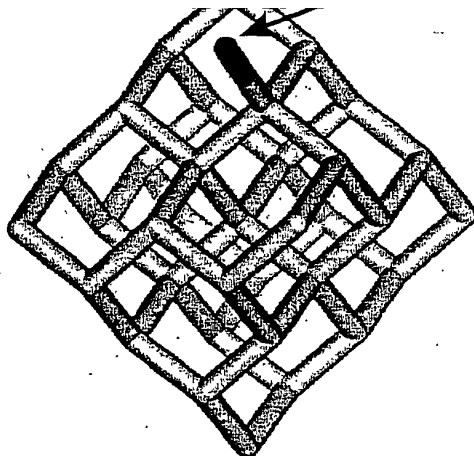


FIG. 5D

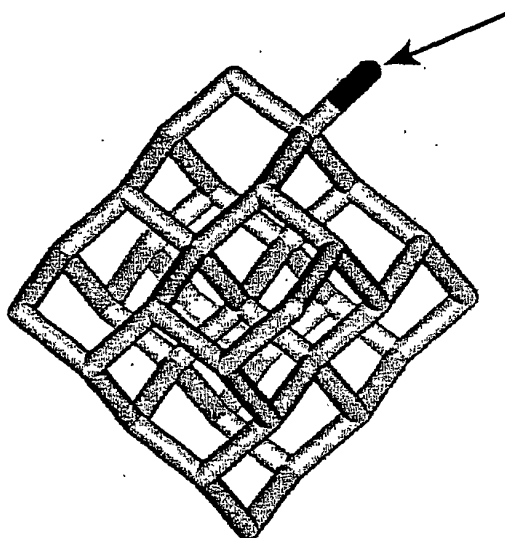


FIG. 5E

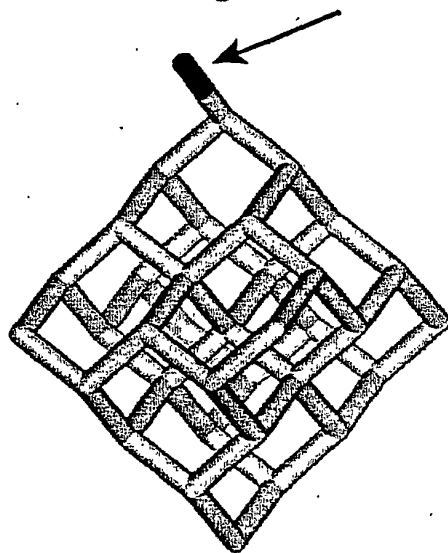


FIG. 5F

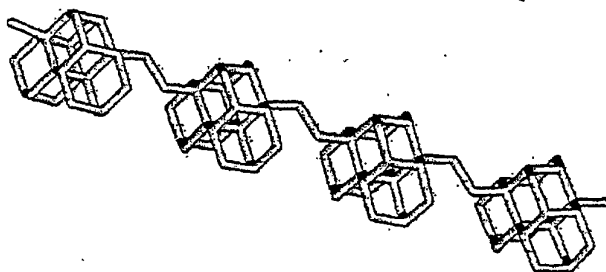


FIG. 5G

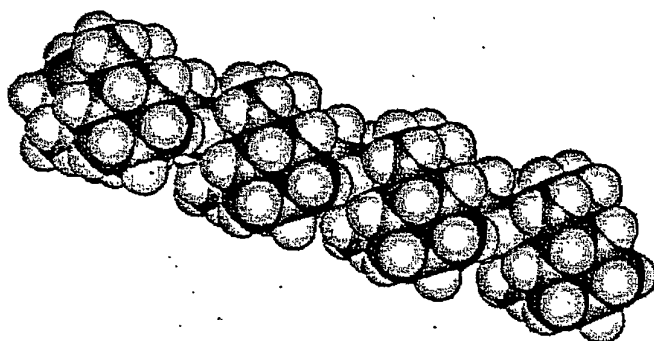
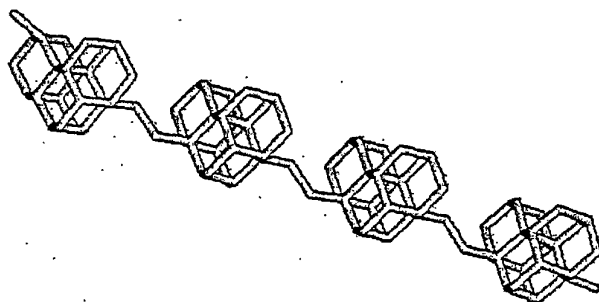


FIG. 5H

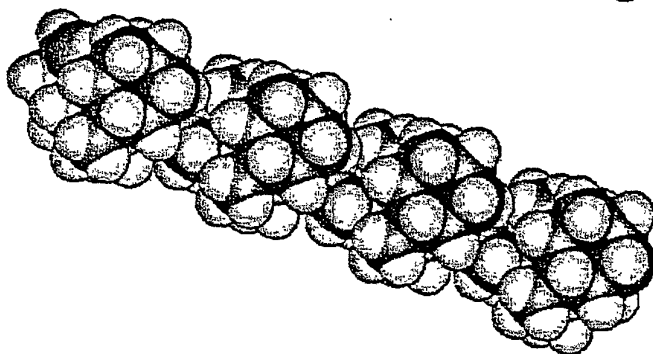




FIG. 6

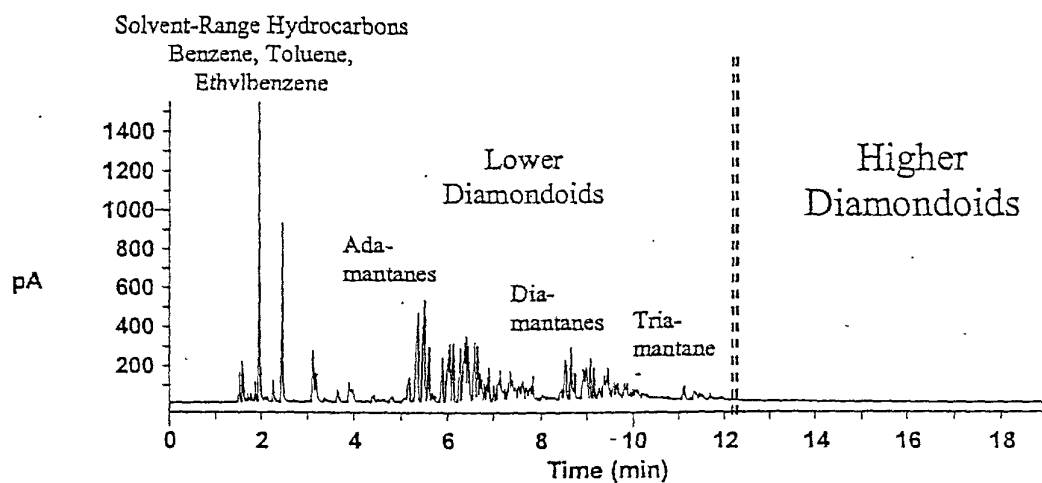


FIG. 7

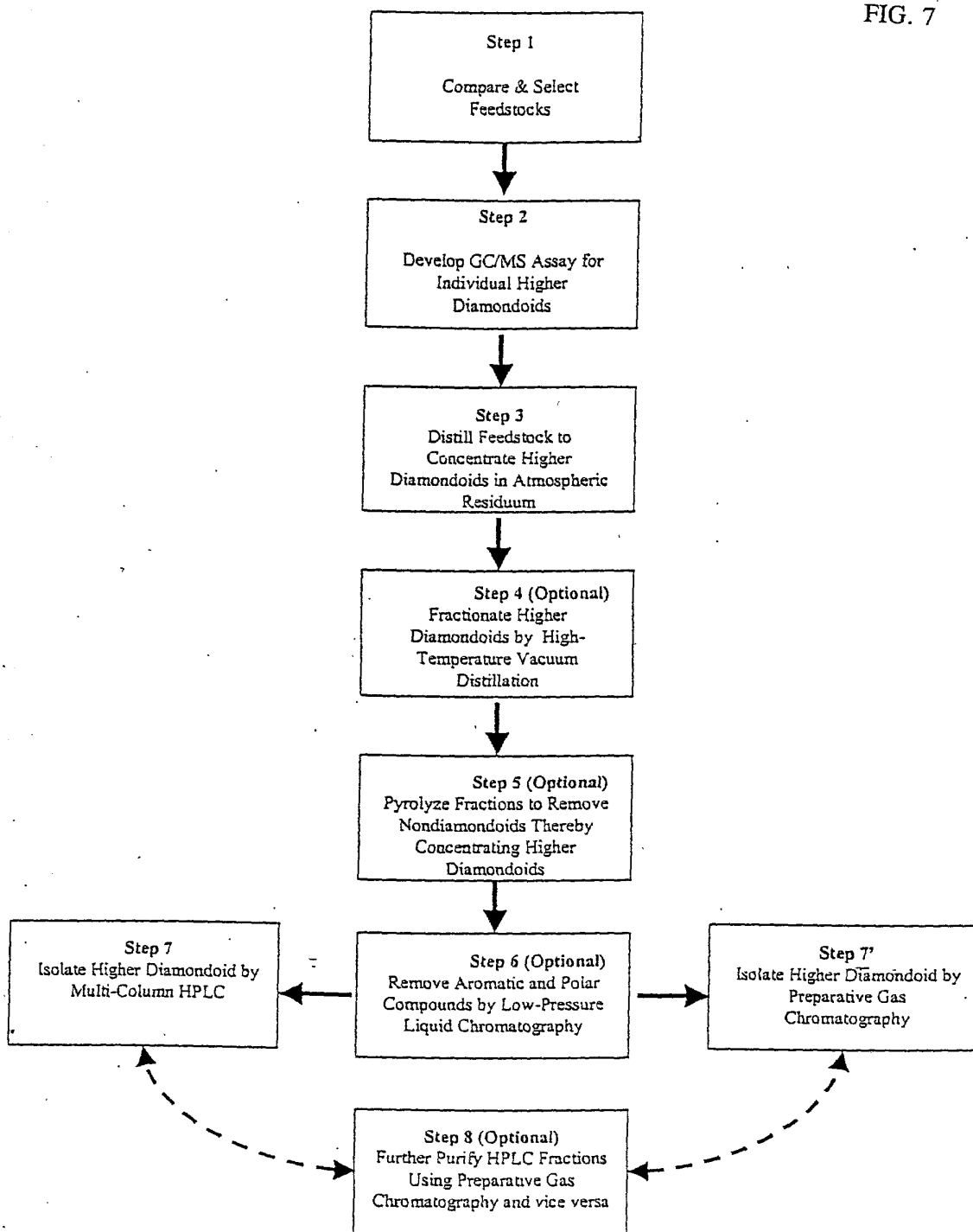


FIG. 8A

Higher Diamondoid	Compound Reference Number	M+ (m/z) (Equals Base Peak)	GC/MS Retention Times* (min.)	GC/MS Relative Retention Times** (min.)
Tetramantane #1	4-1	292	8.10	1.00
Tetramantane #2	4-2	292	8.66	1.07
Tetramantane #3	4-3	292	9.12	1.13
Pentamantane #1	5-1	344	10.40	1.28
Pentamantane #2	5-2	344	11.93	1.47
Pentamantane #3	5-3	344	11.98	1.48
Pentamantane #4	5-4	344	12.38	1.53
Pentamantane #5	5-5	344	12.50	1.54
Pentamantane #6	5-6	344	12.71	1.57
Cyclohexamantane	C-6	342	12.34	1.52
Hexamantane #1	6-1	396	14.46	1.78
Hexamantane #2	6-2	396	14.61	1.80
Hexamantane #3	6-3	396	14.97	1.85
Hexamantane #4	6-4	396	14.99	1.85
Hexamantane #5	6-5	396	15.04	1.86
Hexamantane #6	6-6	396	15.13	1.87
Hexamantane #7	6-7	396	15.22	1.88
Hexamantane #8	6-8	396	15.32	1.89
Hexamantane #9	6-9	396	15.42	1.90
Hexamantane #10	6-10	396	15.45	1.91
Hexamantane #11	6-11	396	15.49	1.91
Hexamantane #12	6-12	396	15.54	1.92
Hexamantane #13	6-13	396	15.60	1.93
Hexamantane #14	6-14	396	15.81	1.95
Hexamantane #15	6-15	396	15.89	1.96
Hexamantane #16	6-16	396	16.05	1.98
Hexamantane #17	6-17	396	16.08	1.99
Heptamantane #1	7-1	394	14.96	1.85
Heptamantane #2	7-2	394	15.53	1.92
Heptamantane #3	7-3	448	17.34	2.14
Heptamantane #4A	7-4A	448	17.70	2.18
Heptamantane #4B	7-4B	448	17.70	2.18
Heptamantane #5	7-5	448	17.71	2.19
Heptamantane #6	7-6	448	17.79	2.20
Heptamantane #7	7-7	448	17.82	2.20
Heptamantane #8	7-8	448	17.99	2.22
Heptamantane #9A	7-9A	448	18.13	2.24
Heptamantane #9B	7-9B	448	18.13	2.24
Heptamantane #9C	7-9C	448	18.13	2.24
Heptamantane #10	7-10	448	18.15	2.24
Heptamantane #11	7-11	448	18.20	2.25
Heptamantane #12	7-12	448	18.21	2.25
Heptamantane #13A	7-13A	448	18.29	2.26
Heptamantane #13B	7-13B	448	18.29	2.26
Heptamantane #13C	7-13C	448	18.29	2.26
Heptamantane #14	7-14	448	18.32	2.26

FIG. 8A cont'd

Higher Diamondoid	Compound Reference Number	M+ (m/z) (Equals Base Peak)	GC/MS Retention Times* (min.)	GC/MS Relative Retention Times** (min.)
Octamantane #1	8-1	446	17.30	2.14
Octamantane #2	8-2	446	17.37	2.14
Octamantane #3	8-3	446	17.42	2.15
Octamantane #4	8-4	446	17.47	2.16
Octamantane #5	8-5	446	17.71	2.19
Octamantane #6	8-6	446	17.82	2.20
Octamantane #7	8-7	446	17.86	2.20
Octamantane #8	8-8	446	18.22	2.25
Octamantane #9	8-9	446	18.46	2.28
Octamantane #10	8-10	446	18.65	2.30
Octamantane #11	8-11	446	18.76	2.32
Nonamantane #1	9-1	498	19.86	2.45
Decamantane #1	10-1	456	18.57	2.29
Decamantane #2	10-2	496	21.33	2.63
Undecamantane#1	11-1	508	21.05	2.60

\* HP-MS5 (30m X 0.25 mm, 0.25 micron film), helium carrier gas,

\*\* Reference to Tetramantane #1

FIG. 8B

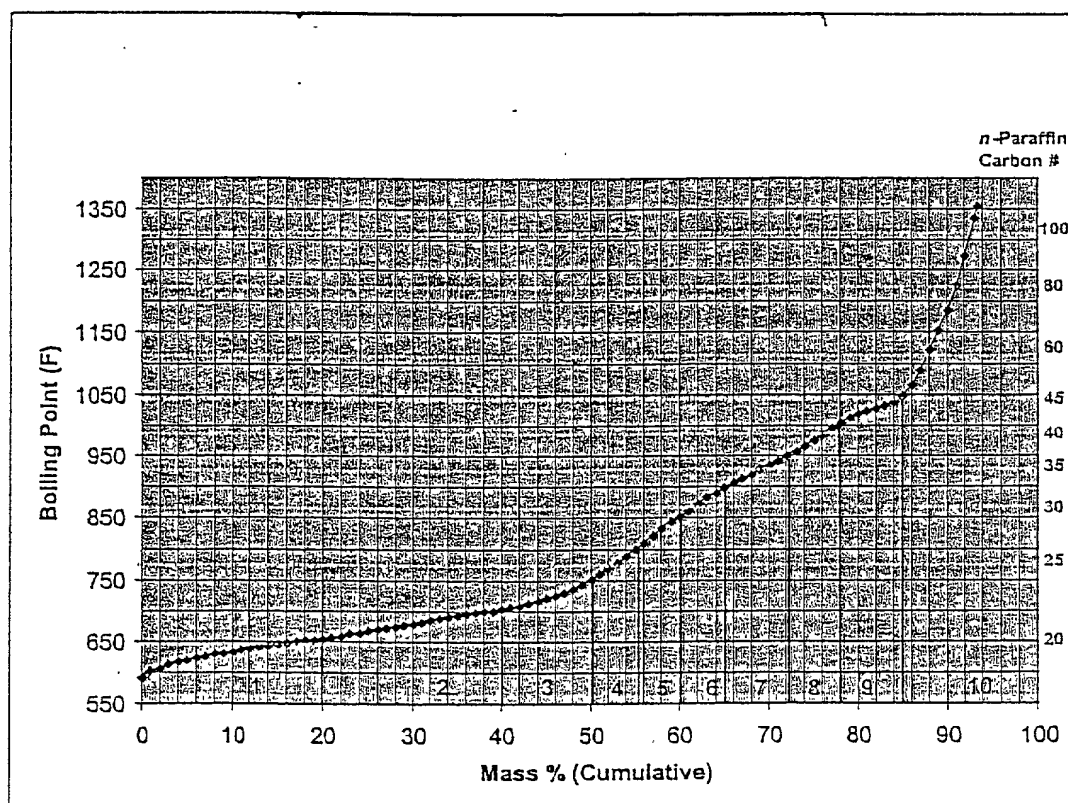
Higher Diamondoid	Compound Reference Number	Fraction Number	Elution Time (min.)	Elution Volume (mL)	Elution Volume Relative to 4-1
Tetramantane #1	4-1	4	119	594	1.00
Tetramantane #2	4-2	7	125	627	1.05
Tetramantane #3	4-3	6	123	616	1.04
Pentamantane #1	5-1	11	134	669	1.13
Pentamantane #2	5-2	19	151	754	1.27
Pentamantane #3	5-3	28	170	850	1.43
Pentamantane #4	5-4	22	157	786	1.32
Pentamantane #5	5-5	19	151	754	1.27
Pentamantane #6	5-6	20	153	765	1.29
Cyclohexamantane	C-6	23	159	797	1.34
Hexamantane #1	6-1	33	181	903	1.52
Hexamantane #2	6-2	29	172	861	1.45
Hexamantane #3	6-3	43	202	1012	1.70
Hexamantane #4	6-4	33	181	903	1.52
Hexamantane #5	6-5	35	185	924	1.56
Hexamantane #6	6-6	63	242	1211	2.04
Hexamantane #7	6-7	37	189	945	1.59
Hexamantane #8	6-8	39	193	967	1.63
Hexamantane #9	6-9	39	193	967	1.63
Hexamantane #10	6-10	48	214	1071	1.80
Hexamantane #11	6-11	36	187	935	1.57
Hexamantane #12	6-12	44	205	1024	1.72
Hexamantane #13	6-13	36	187	935	1.57
Hexamantane #14	6-14	39	193	967	1.63
Hexamantane #15	6-15	45	207	1036	1.74
Hexamantane #16	6-16	44	205	1024	1.72
Hexamantane #17	6-17	49	217	1083	1.82
Heptamantane #1	7-1	45	207	1036	1.74
Heptamantane #2	7-2	41	198	989	1.66
Heptamantane #3	7-3	61	238	1190	2.00
Heptamantane #4A	7-4A	90	304	1519	2.56
Heptamantane #4B	7-4B	90	304	1519	2.56
Heptamantane #5	7-5	76	270	1349	2.27
Heptamantane #6	7-6	67	251	1253	2.11
Heptamantane #7	7-7	—	—	—	—
Heptamantane #8	7-8	59	234	1172	1.97
Heptamantane #9A	7-9A	60	236	1181	1.99
Heptamantane #9B	7-9B	62	240	1200	2.02
Heptamantane #9C	7-9C	78	274	1370	2.31
Heptamantane #10	7-10	86	291	1455	2.45
Heptamantane #11	7-11	—	—	—	—
Heptamantane #12	7-12	—	—	—	—
Heptamantane #13A	7-13A	58	233	1163	1.96
Heptamantane #13B	7-13B	74	266	1328	2.24
Heptamantane #13C	7-13C	90	304	1519	2.56
Heptamantane #14	7-14	70	257	1285	2.16

FIG. 8B cont'd

Higher Diamondoid	Compound Reference Number	Fraction Number	Elution Time (min.)	Elution Volume (mL)	Elution Volume Relative to 4-1
Octamantane #1	8-1	81	280	1402	2.36
Octamantane #2	8-2	83	285	1423	2.40
Octamantane #3	8-3	64	244	1221	2.06
Octamantane #4	8-4	—	—	—	—
Octamantane #5	8-5	63	242	1211	2.04
Octamantane #6	8-6	79	276	1381	2.32
Octamantane #7	8-7	71	259	1296	2.18
Octamantane #8	8-8	84	287	1434	2.41
Octamantane #9	8-9	74	266	1328	2.24
Octamantane #10	8-10	80	280	1402	2.36
Octamantane #11	8-11	85	289	1445	2.43
Nonamantane #1	9-1	89	297	1487	2.50
Decamantane #1	10-1	83	285	1423	2.40
Decamantane #2	10-2	—	—	—	—
Undecamantane#1	11-1	101	355	1774	2.99

ODS HPLC Whatman ODS-II 10/50  
 (2 Columns in series), acetone mobile phase @5.0 mL/min.

FIG. 9



Distillation Cuts Made on Atmospheric Resid of Feedstock B (°C)

[illegible]

Higher Diamondoid  
Tetramantanes  
Pentamantanes  
Cyclohexamantanes  
Hexamantanes  
Heptamantanes  
Octamantanes  
Nonamantanes  
Decamantanes  
Undecamantanes



FIG. 11A

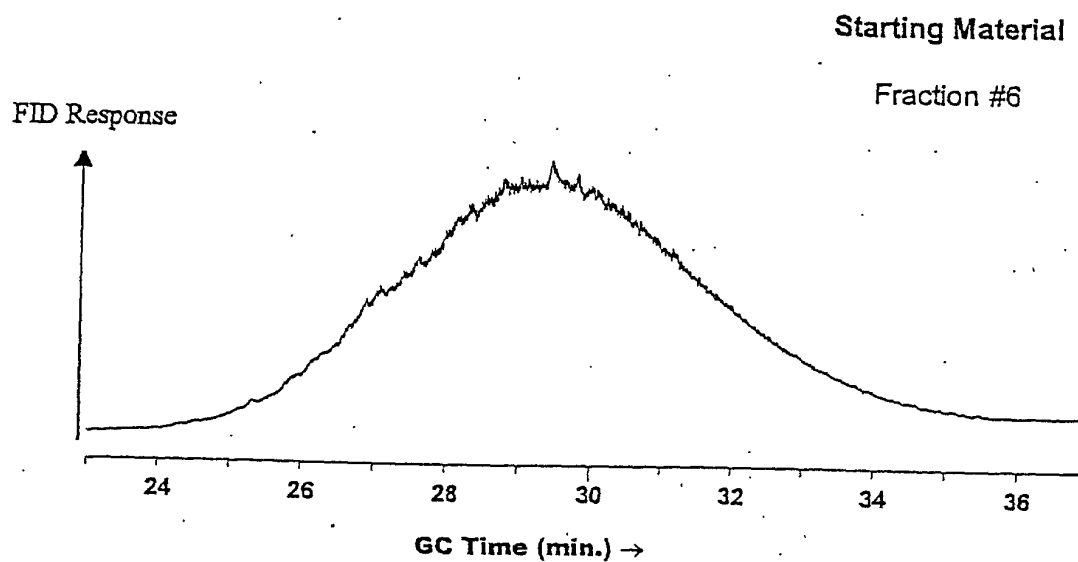
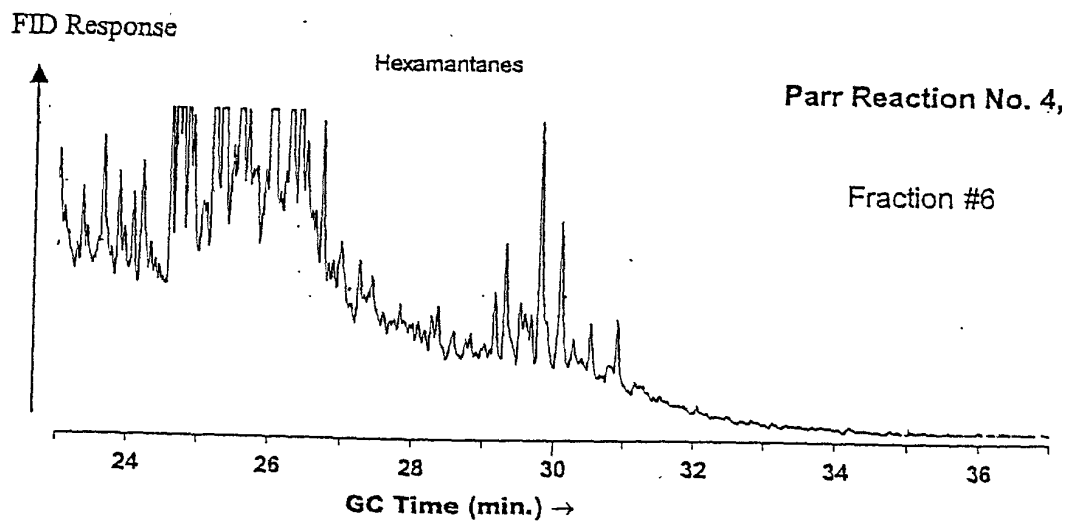


FIG. 11B



### Hexamantane

[illegible]

FIG. 12B

[illegible]

FIG. 13A

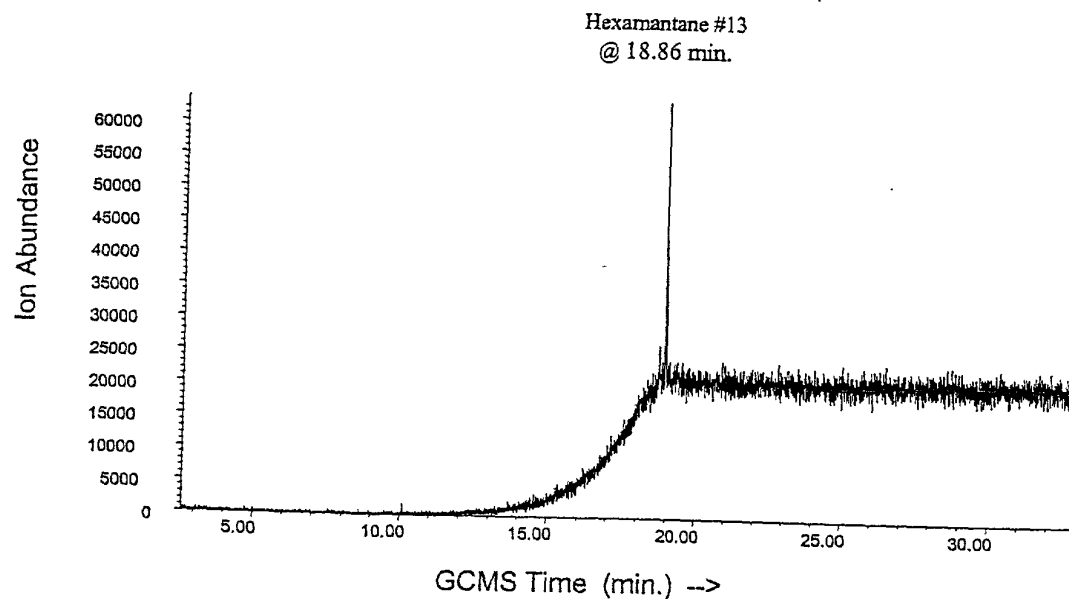


FIG. 13B

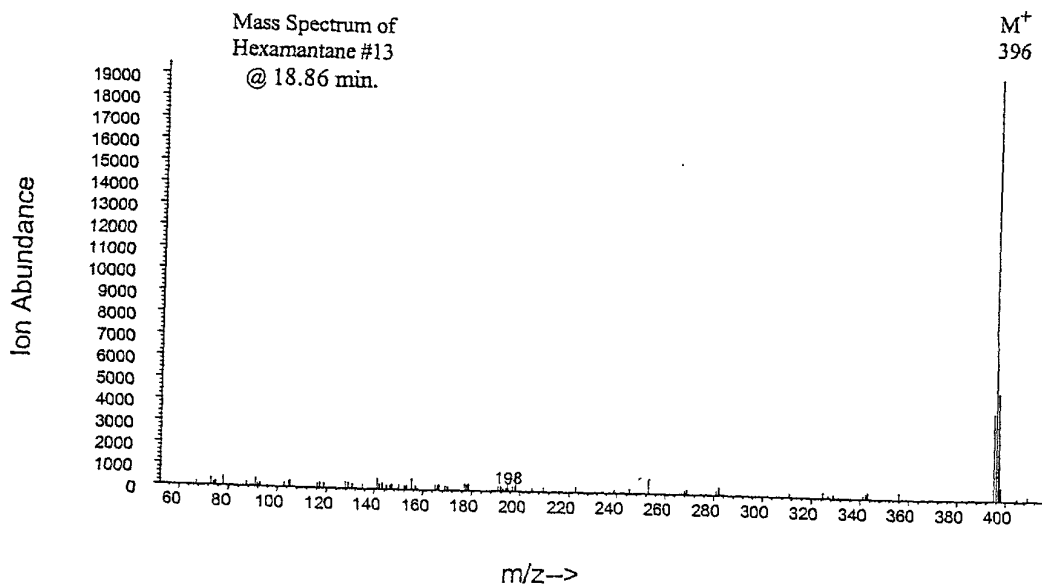


FIG. 14A

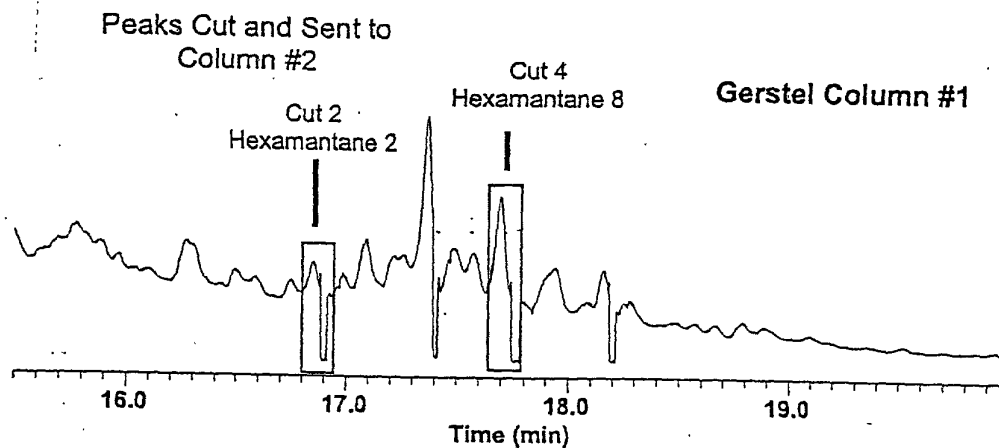


FIG. 14B

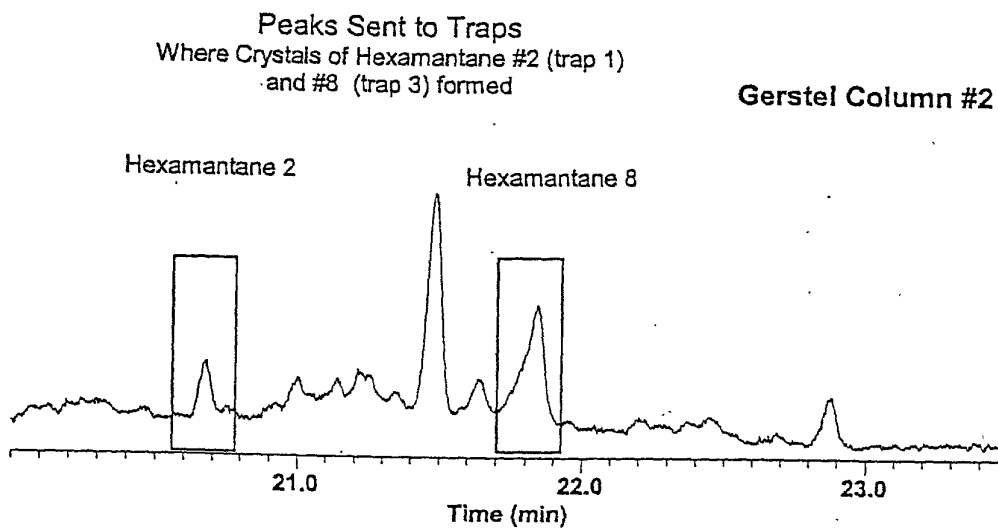


FIG. 15A

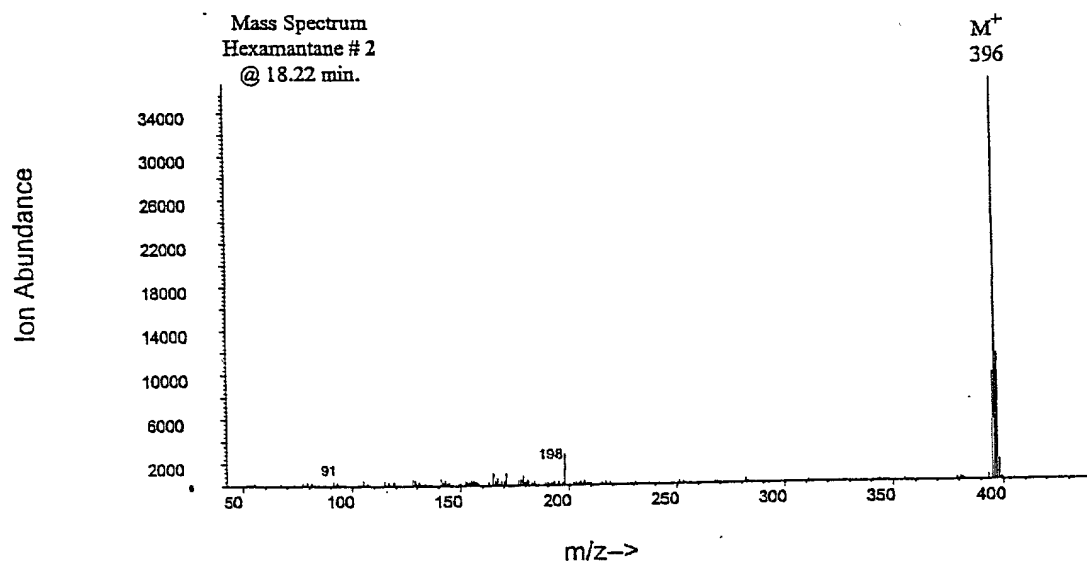
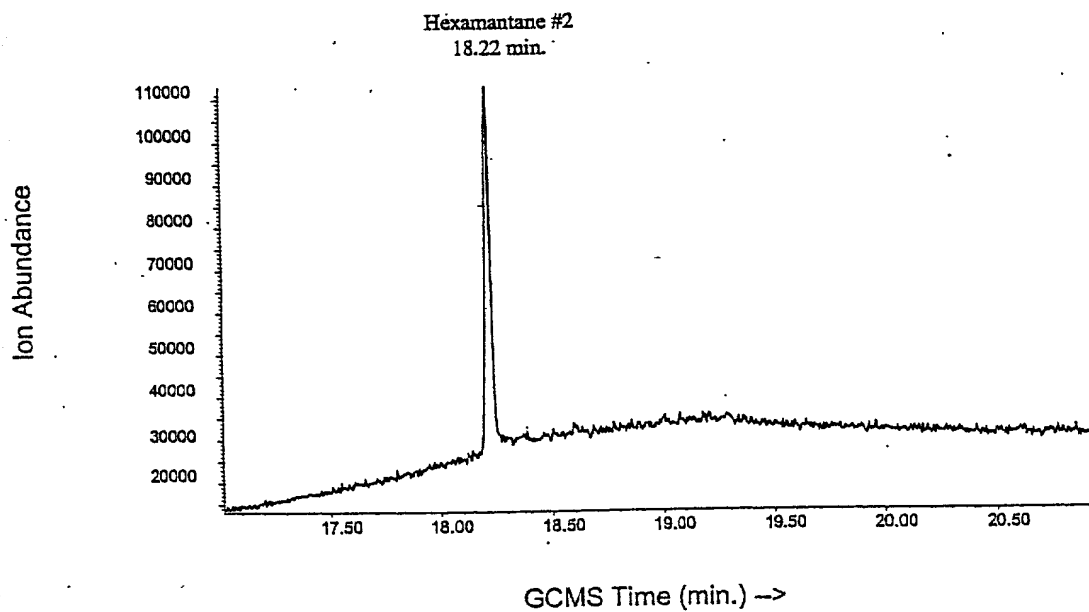


FIG. 15B

FIG. 15C

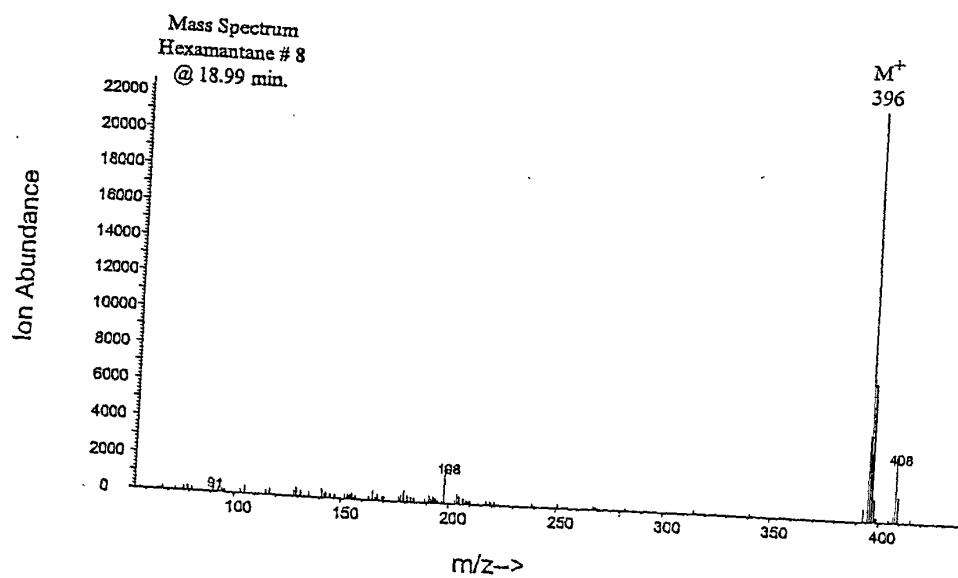
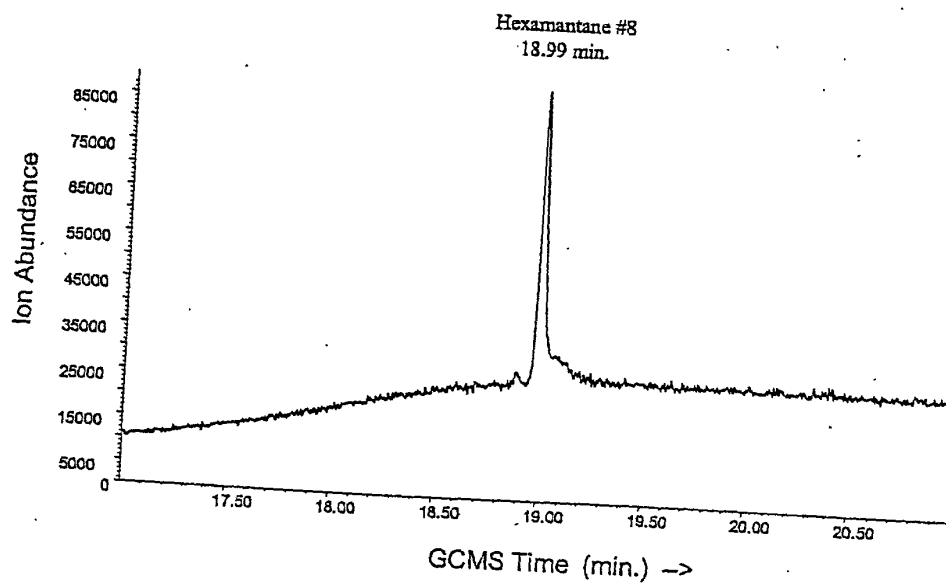
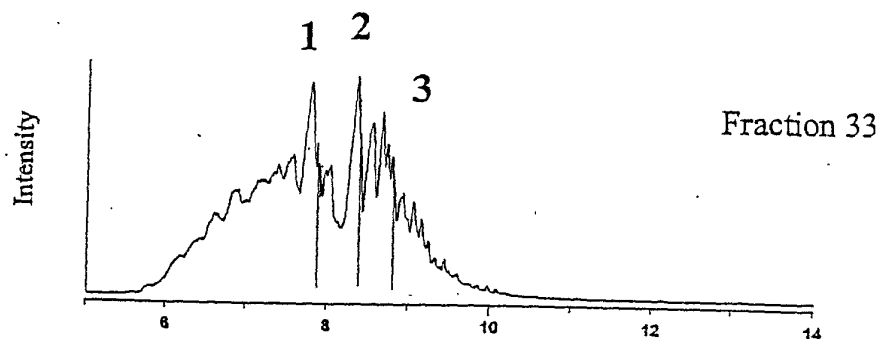


FIG. 15D

FIG. 16

First  
Column



Second  
Column

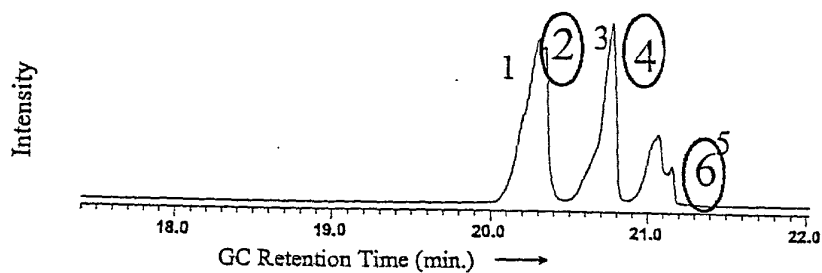




FIG. 17

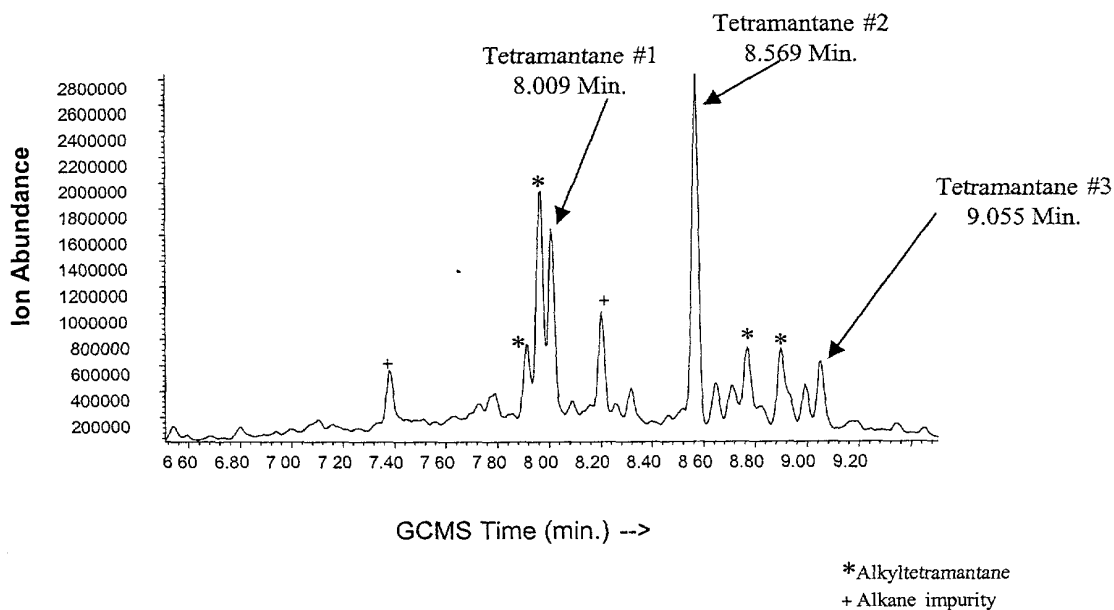
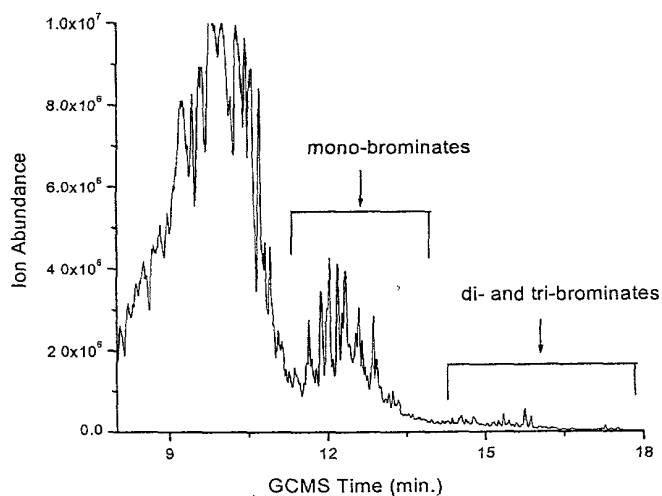


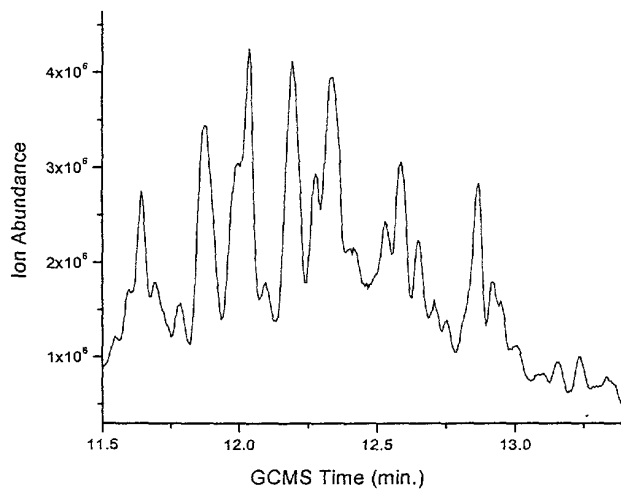
FIG. 18

TIC of Bromination Products of a Feedstock Containing a Mixture of Tetramantanes and Alkyltetramantanes



**FIG. 19**

TIC of Mono-brominated Products



**FIG. 20**

TIC of Di- and Tri-brominated Products

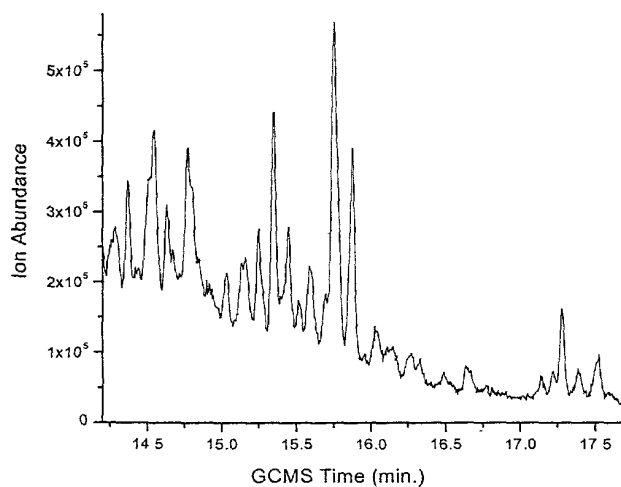


FIG. 21

GC of a Mono-brominated Tetramantane (\*, 12.038 min.)

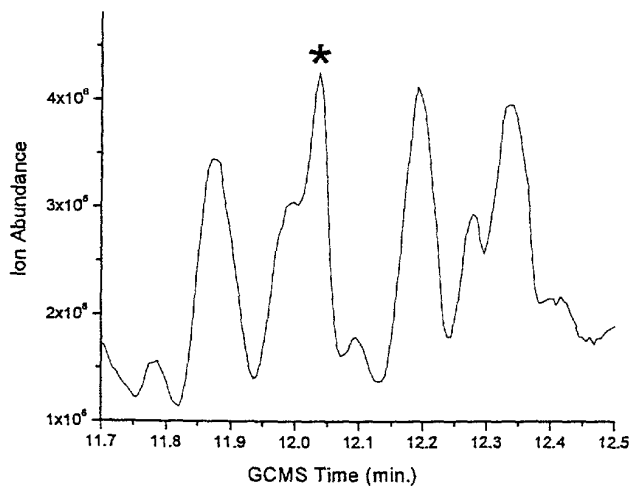


FIG. 22

GCMS of the Mono-brominated Tetramantane @ 12.038 min.

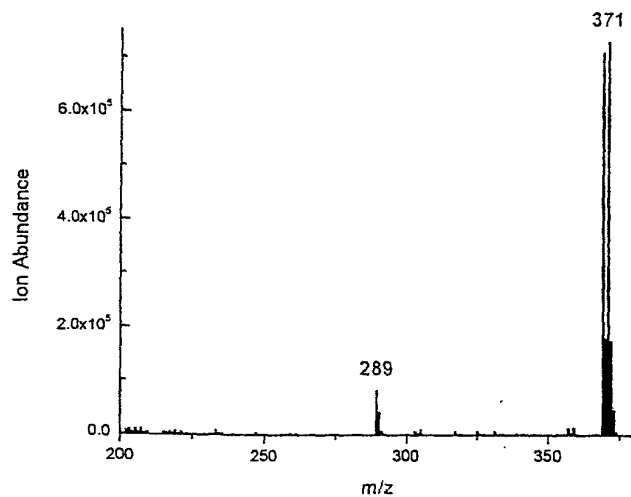


FIG. 23

GC of Mono-brominated Methyltetramantanes (\*, 11.644 and 11.992 min.)

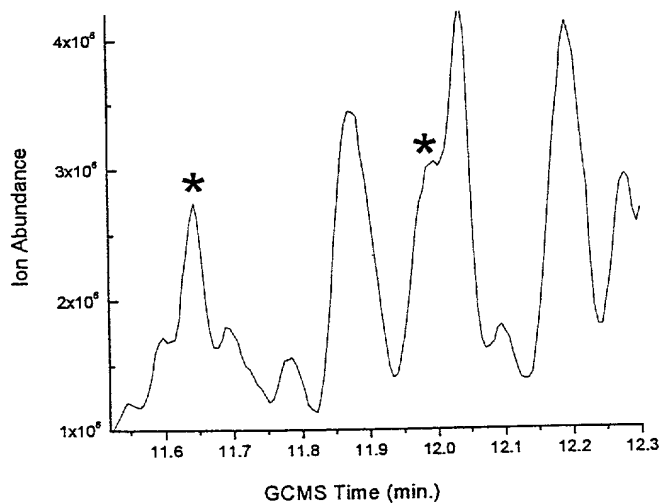


FIG. 24

GCMS of the Monobrominated Methyltetramantanes @ 11.644 (inset) and 11.992 min.

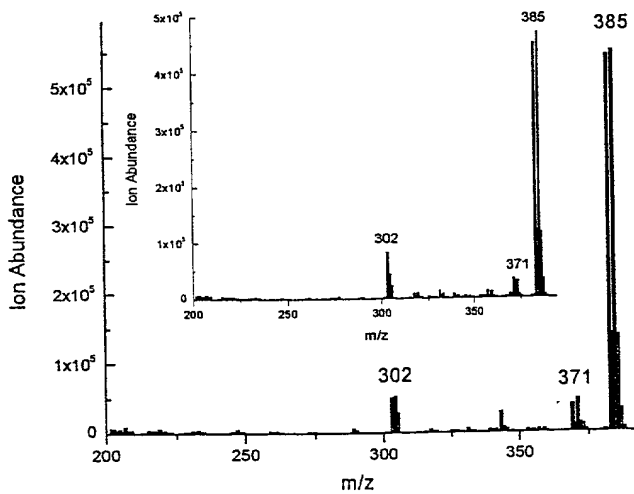


FIG. 25

GC of a Mono-brominated Dimethyltetramantane (\*, 12.192 min.)

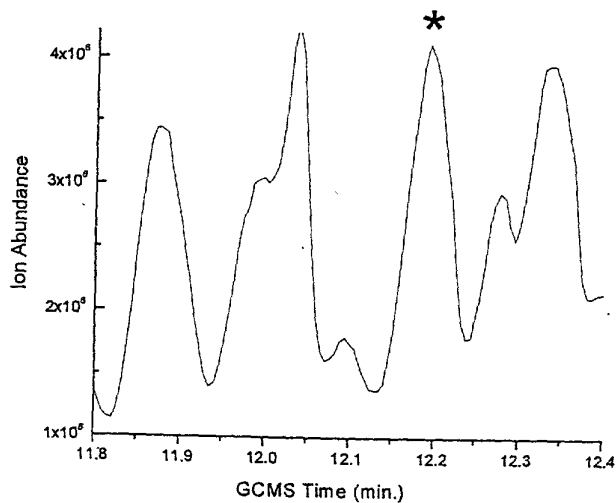
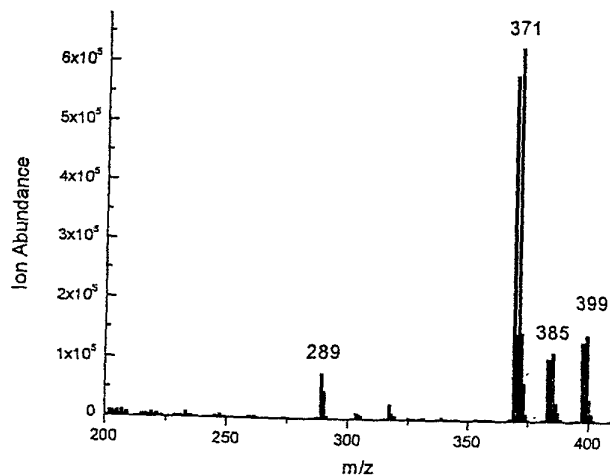


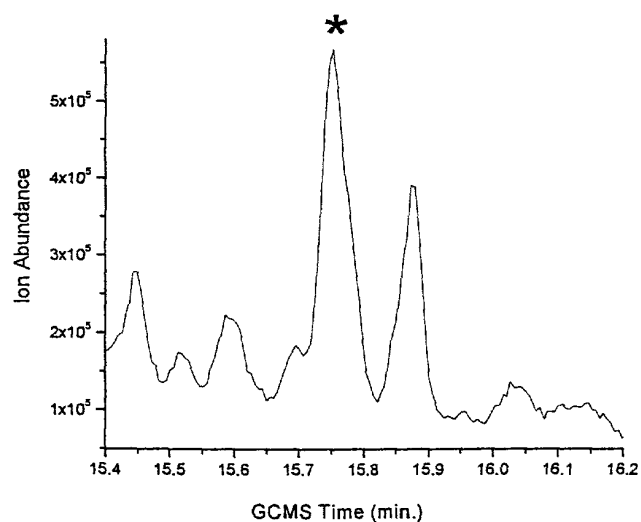
FIG. 26

GCMS of the Monobrominated Dimethyltetramantane @ 12.192 min.



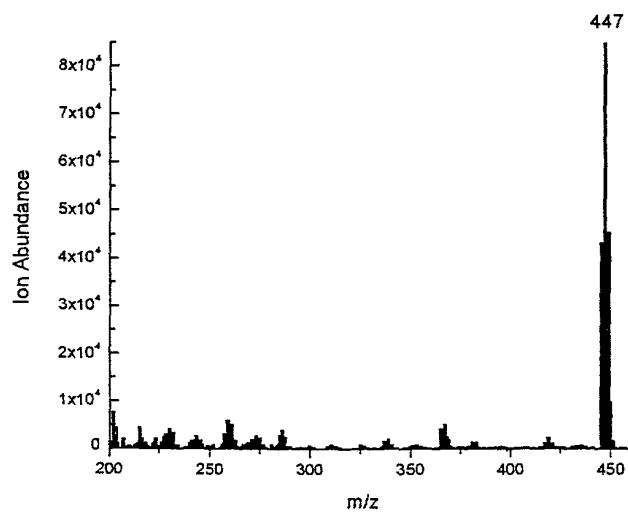
**FIG. 27**

GC of a Di-brominated Tetramantane (\*, 15.753 min.)



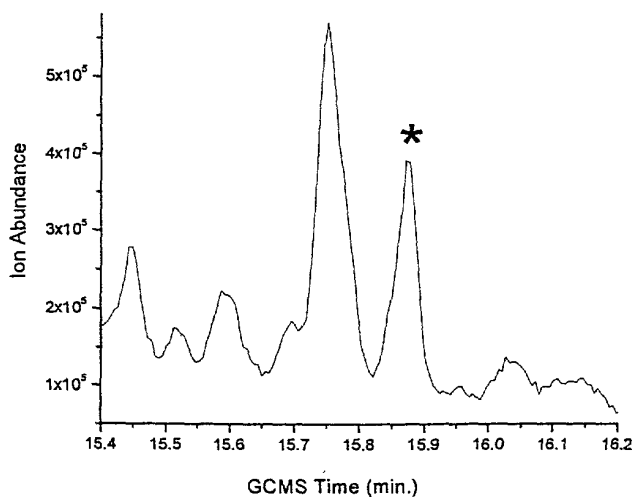
**FIG. 28**

GCMS of the Di-brominated Tetramantane @ 15.753 min.



**FIG. 29**

GC of a Di-brominated Methyltetramantane (\*, 15.879 min.)



**FIG. 30**

GCMS of the Di-brominated Methyltetramantane @ 15.879 min.

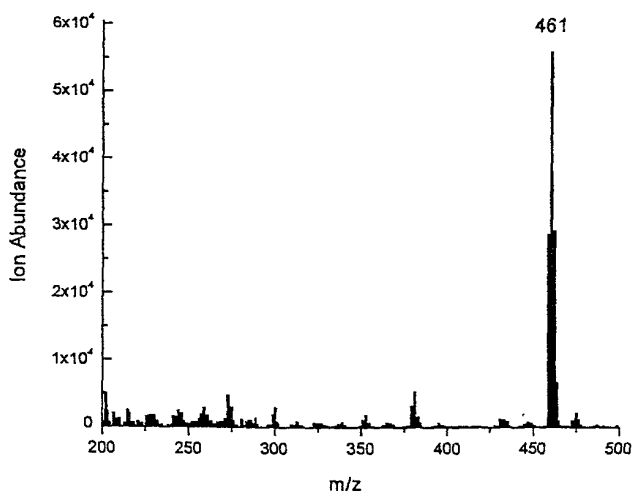


FIG. 31

GC of a Tri-brominated Tetramantane (\*, 17.279 min.)

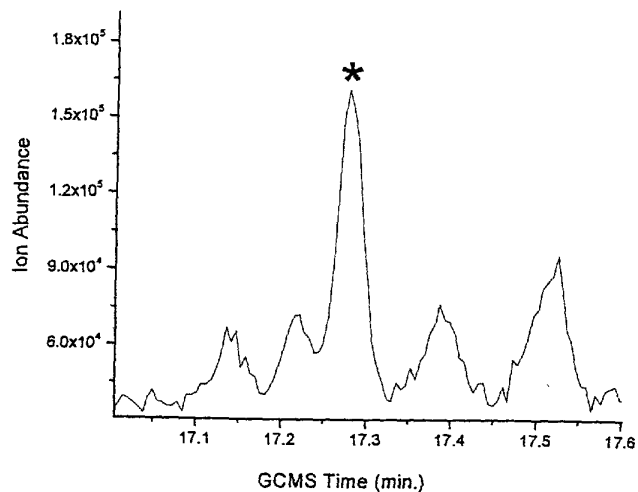


FIG. 32

GCMS of the Tri-brominated Tetramantane @ 17.279 min.

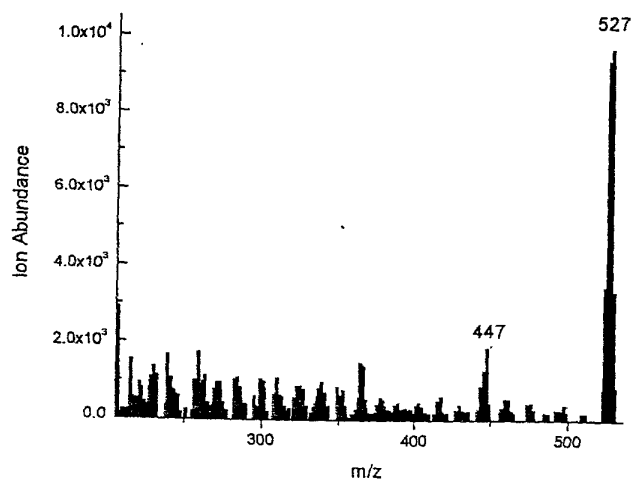




FIG. 33

GC of a Tri-brominated Methyltetramantane (\*, 15.250 min.)

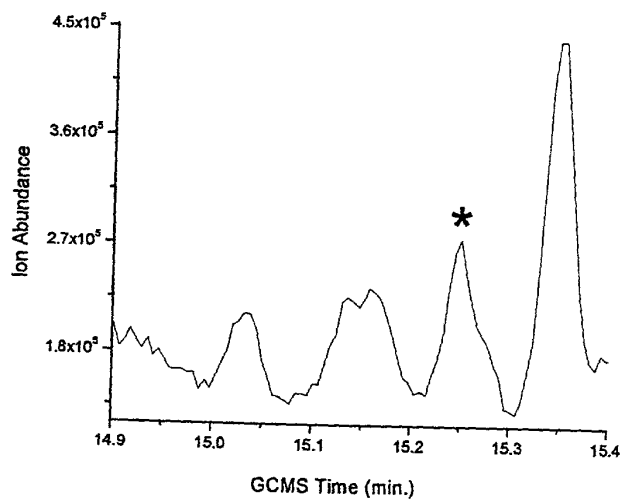


FIG. 34

GCMS of the Tri-brominated Methyltetramantane @ 15.250 min.

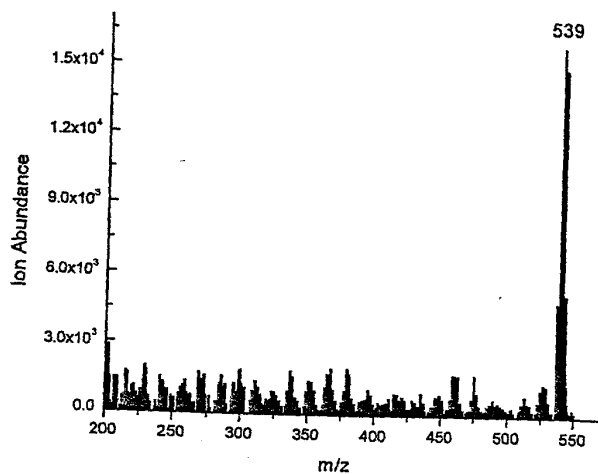


FIG. 35

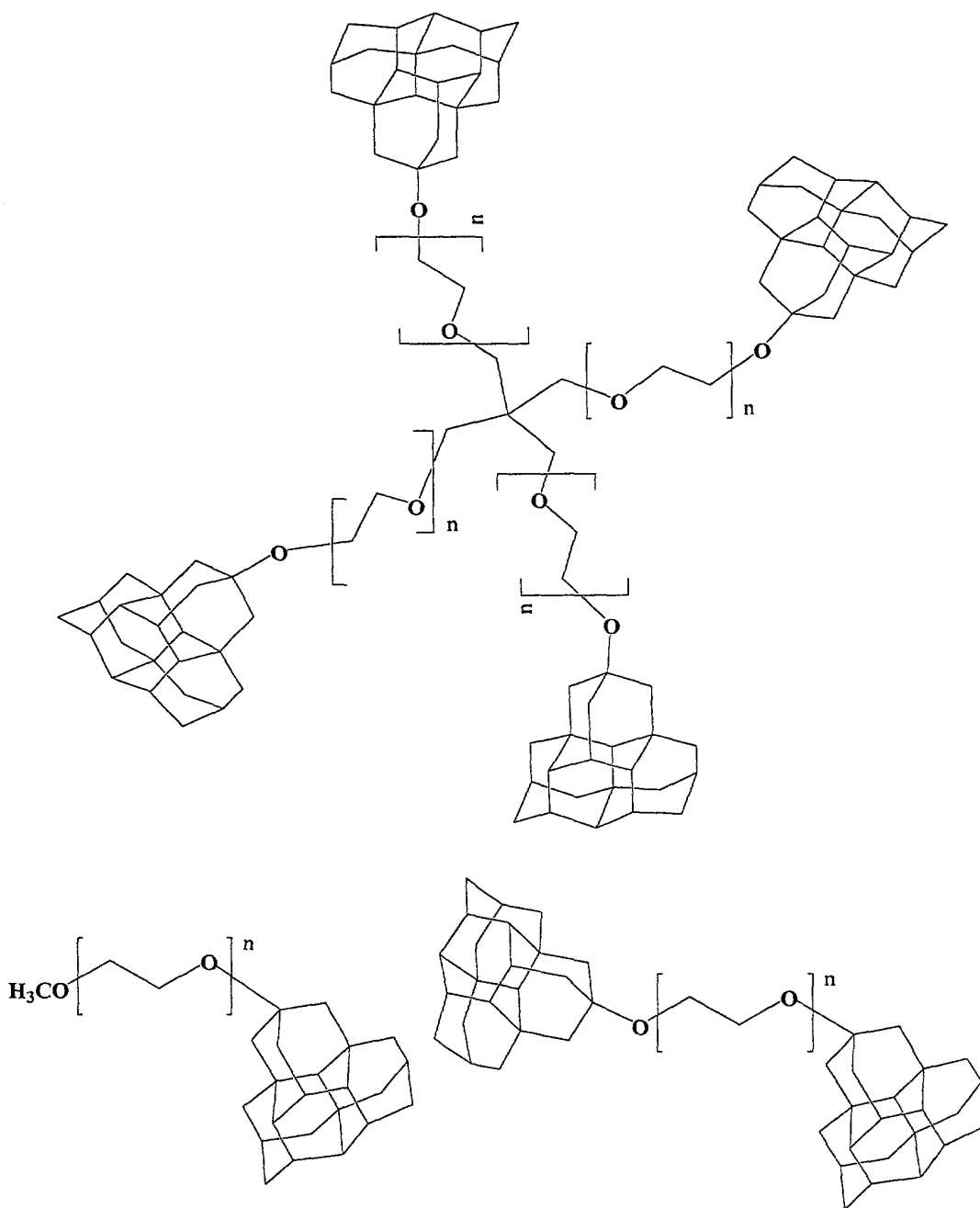


FIG. 36

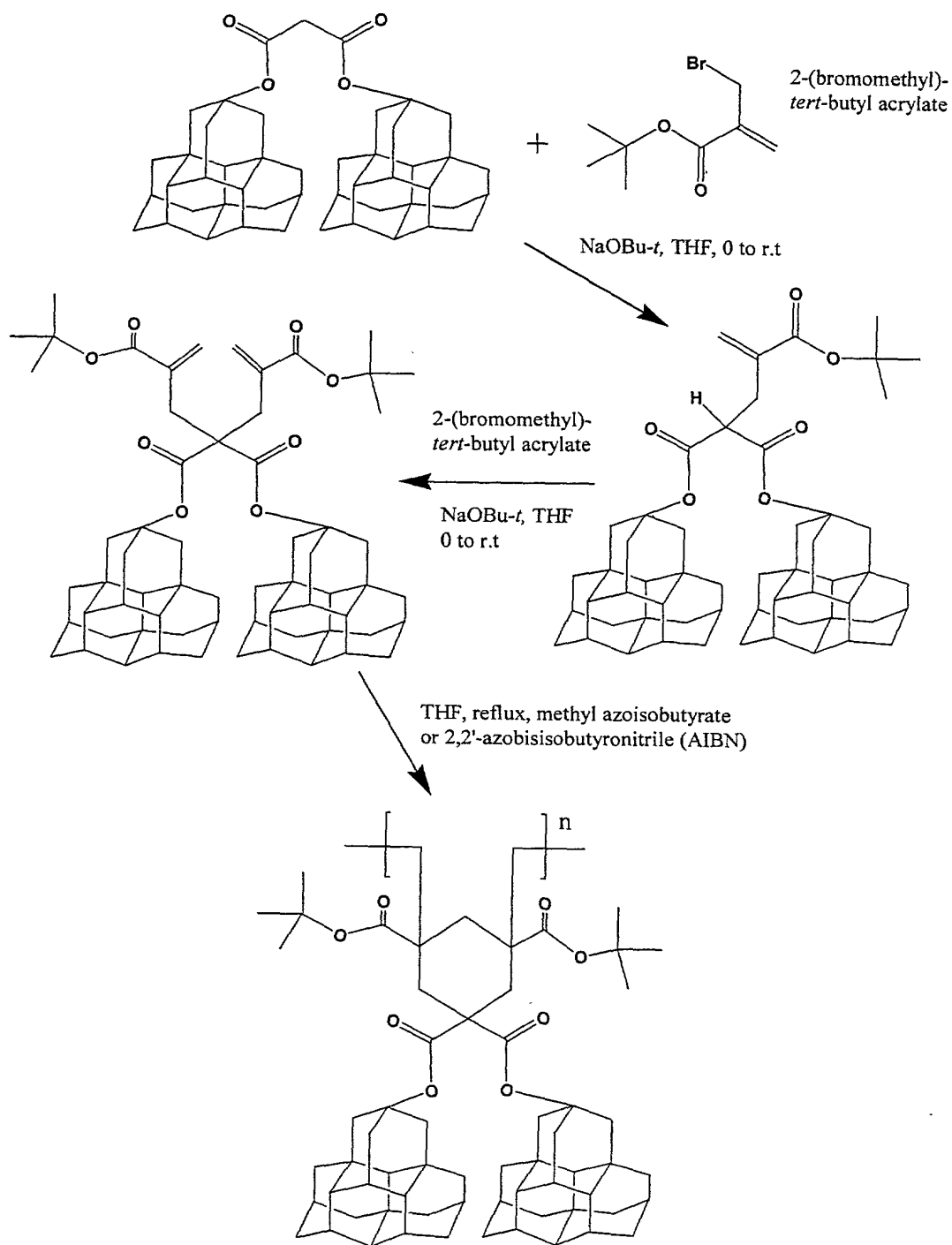


FIG. 37A

Aromatic bisphenols: HO-Ar-OH

Ar:

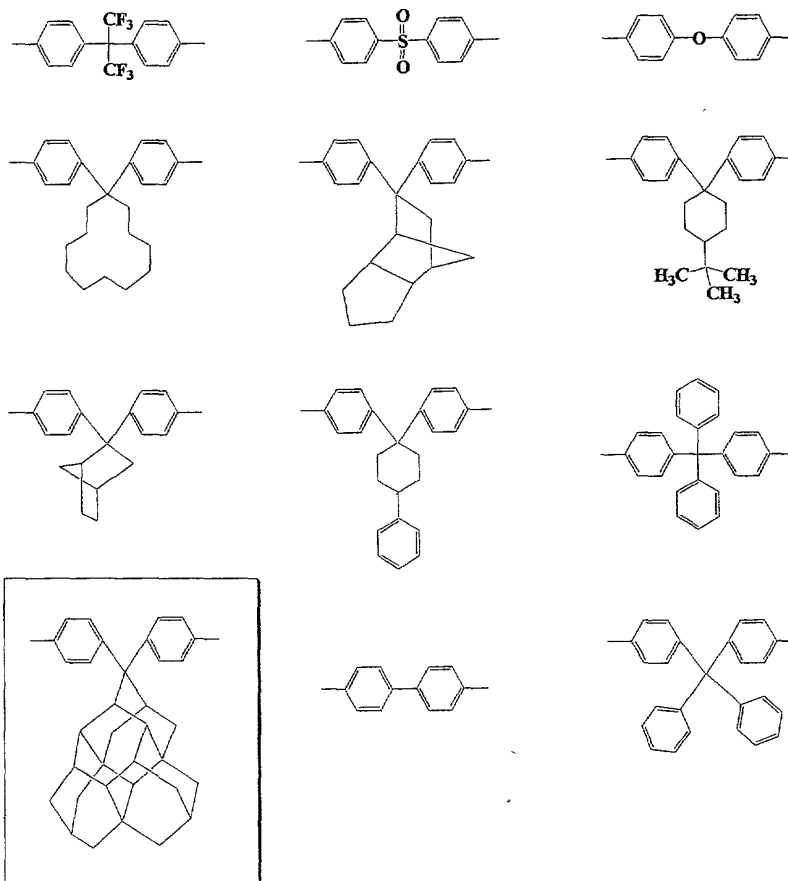


FIG. 37B

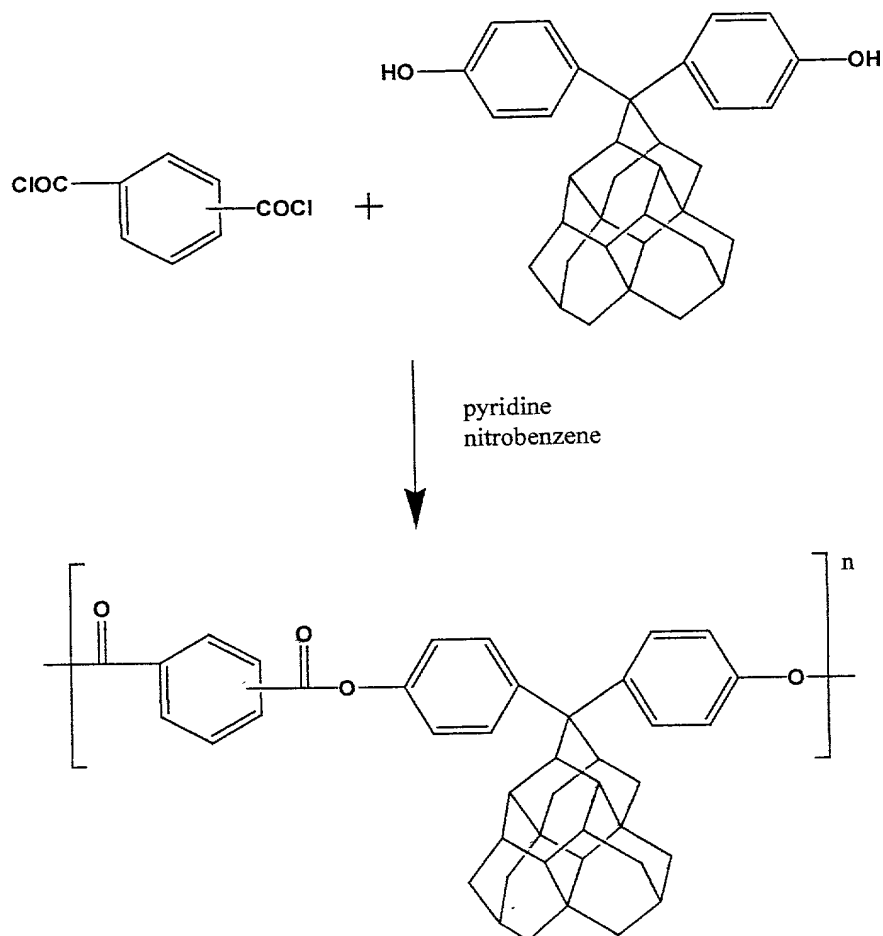
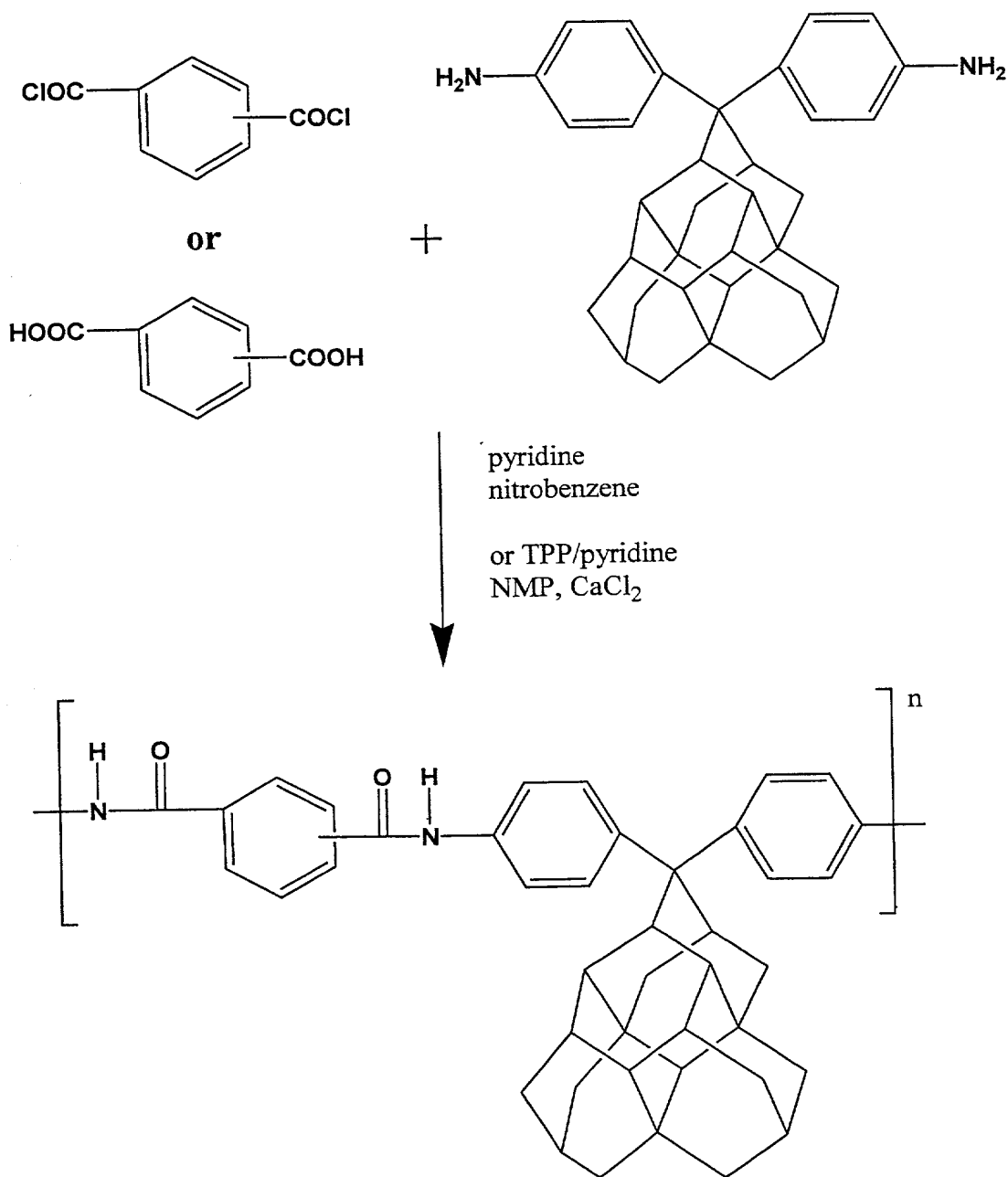


FIG. 38



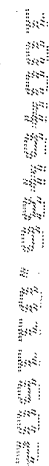
[illegible]

FIG. 39B

Aromatic Dianhydride

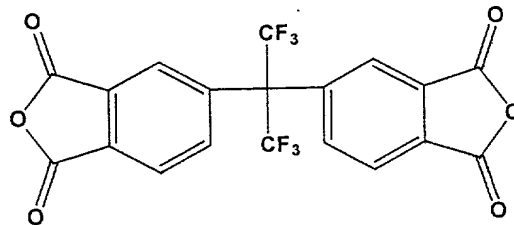
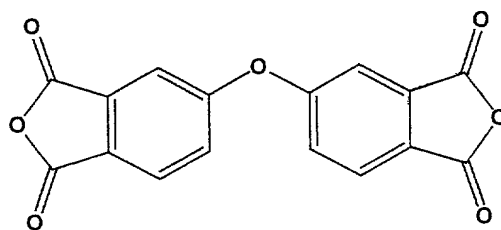
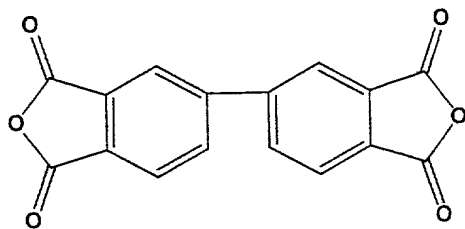
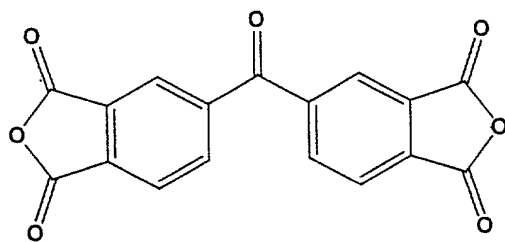




FIG. 40

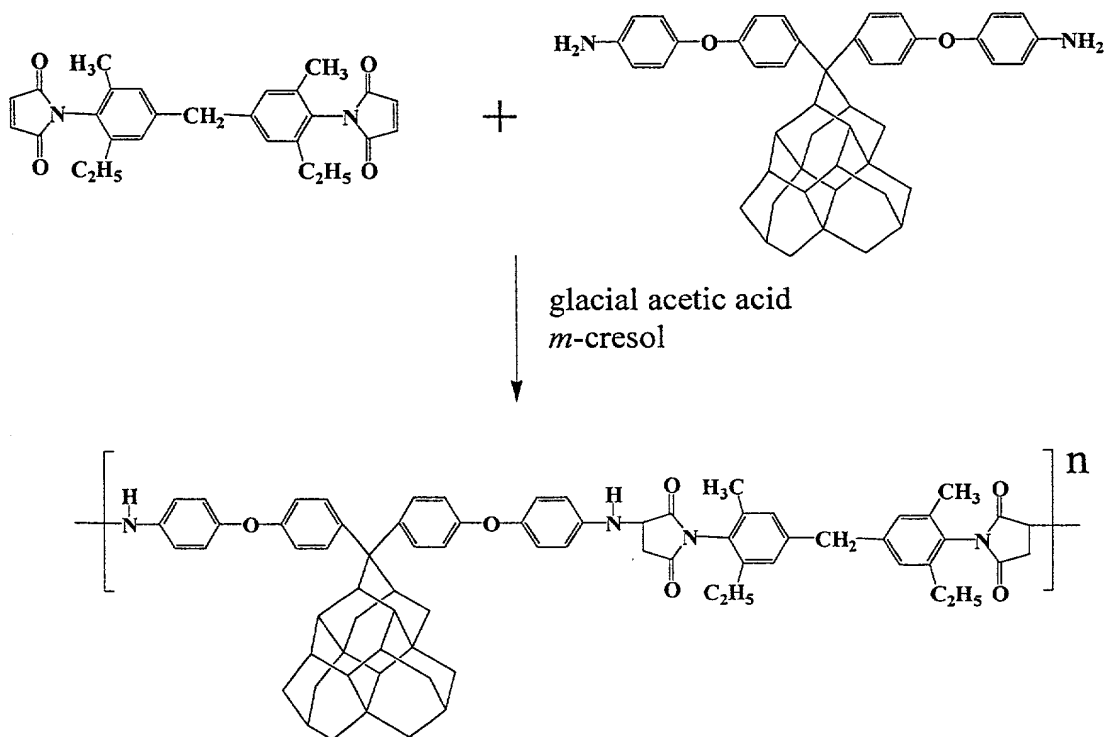


FIG. 41

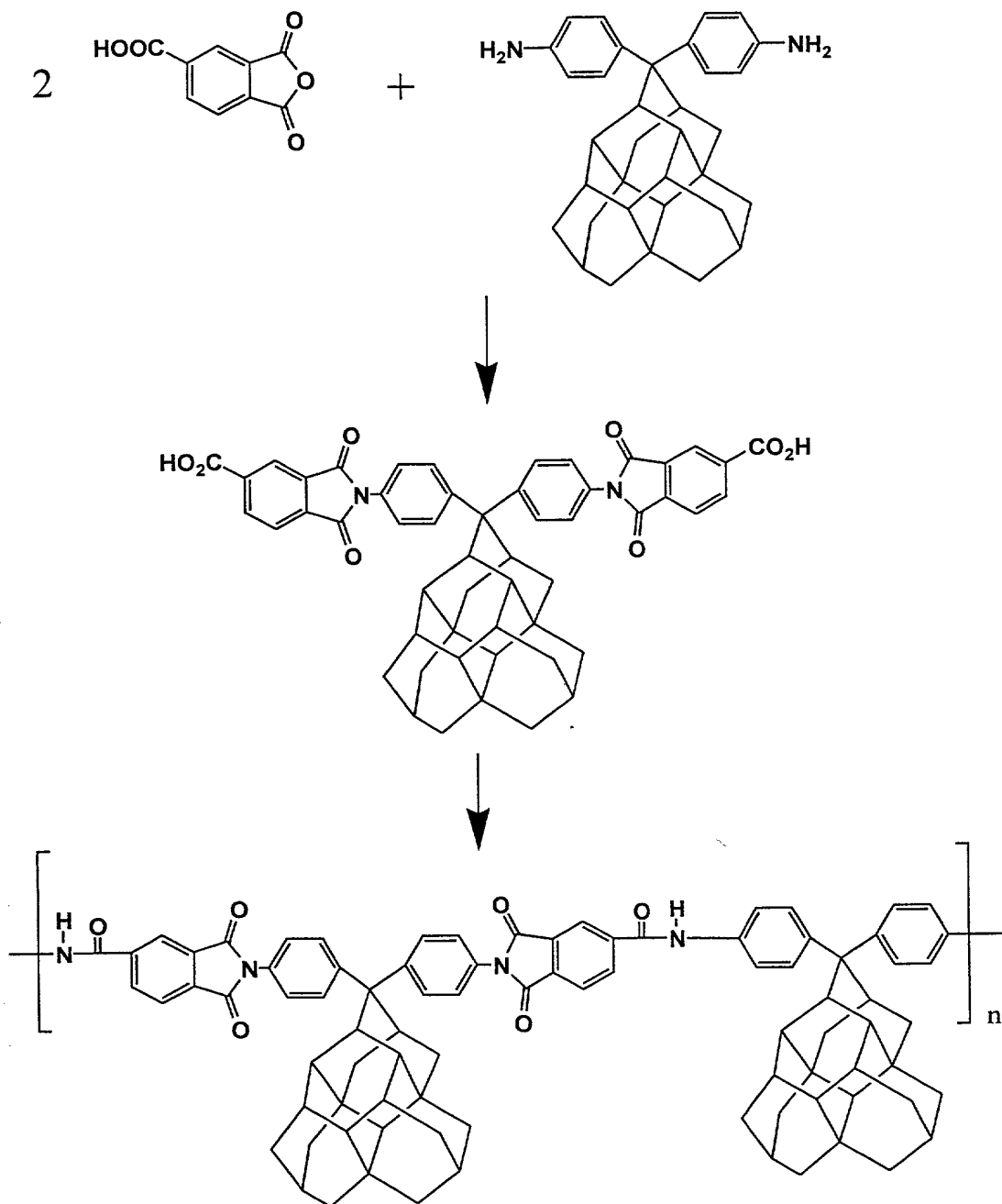


FIG. 42

Aromatic diamines:  $\text{H}_2\text{N-Ar-NH}_2$

Ar:

